Design and Development Division – Transmission

Class Environmental Assessment For Minor Transmission Facilities

Class Environmental Assessment For Minor Transmission Facilities*

Pursuant to the Environmental Assessment Act, 1975 and Exemption Orders OHE-5, OHG-7 and OHL-12

March 1978
Revision 1 April 1979
Revision 2 January 1984
Revision 3 March 1986

*Formerly called
Program Environmental Assessment Document

This Class Environment Assessment For Minor Transmission Facilities document was approved by Order-in-Council number 536/86 on March 6, 1986, and is subject to the following conditions;

1. Except as provided by the subsequent conditions, the proponent shall comply with all the provisions of the Class Environmental Assessment as amended which are herein incorporated by reference.
2. The *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* do not form a part of the Class Environment Assessment.
3. Ontario Hydro shall carry out a re-evaluation of the Class EA covered by this approval and advise the Minister of the Environment of the results of this re-evaluation by December 31, 1989. At that time, Ontario Hydro shall specify the manner in which it proposes to continue to ensure that the purposes of the *Environmental Assessment Act* are achieved for projects within the Class.
4. This approval shall terminate on December 31, 1990 or such later date as the Minister may specify, from time to time, by notice in writing to the proponent and in the *Ontario Gazette*.

Preface

The purpose of this document is to provide the information which will enable the Ministry of the Environment to approve, following a single review, certain Ontario Hydro undertakings which will occur frequently, will be relatively small in scale, will have acceptable environmental effects, and can be planned and constructed in accordance with a common process. While ensuring the adherence by Ontario Hydro to a complete environmental study before implementing any undertaking within this class of undertakings, this approval will reduce the commitment of both Ministry of the Environment and Ontario Hydro personnel to unnecessary individual reviews and approvals.

Background

A proclamation approved by the Lieutenant-Governor in Council, effective October 20, 1976, brought into force the *Environmental Assessment Act, 1975* and *Regulations and Exemptions Orders under the Act* for Ontario Government ministries and certain public bodies, including Ontario Hydro.

Included in the Act are provisions whereby the Lieutenant-Governor in Council may:

- Exempt any undertaking as defined by the Act, from application of the Act, "subject to such terms and conditions as the Minister (of the Environment) may impose". (Section 30)
- Make regulations defining, as *a class of undertakings*, any number of individual undertakings having "the same attributes, qualities and characteristics". (Section 42)

Pursuant to these provisions, Exemption Orders OHE−5, OHG−7 and OHL−12, provided exemptions for certain types of undertakings as follows:

OHE−5

The program of planning, designing, construction, operating, and maintaining in order to upgrade or rehabilitate existing transmission lines and to upgrade, expand or rehabilitate existing transformer stations or switching stations which involve changes of rights-of-way, replacement of poles or towers, or extensions to existing sites.

OHG−7

The program of planning, designing, construction, operating and maintaining minor new transmission line, transformer station and switching station projects defined as:

- New transmission lines 2 to 8 km in route length which are capable of operating at a nominal voltage of at least 230 kV;
- New transmission lines more than 2 km in route length which are capable of operating at a nominal voltage of 115 kV; or
- New transformer and switching station projects which are capable of operating at a nominal voltage of not than 230 kV.

OHL−12

The program of planning, designing, construction, operating and maintaining communication towers.

In these three cases, the Exemption Orders imposed the conditions that Ontario Hydro *must*:

- Submit by December 1, 1976, and update semi-annually, a list of all proposed projects coming within the definition of the class.
- Submit a program environmental assessment covering the class of undertakings before April 1, 1978.

A program EA was prepared to cover the undertakings described in OHE−5, OHG−7 and OHL−12 and was submitted to meet this latter requirement. This was approved on December 27, 1980, subject to eight conditions. The document has now been revised to conform with the requirement of condition number 4, which states:

4) Ontario Hydro shall carry out a re-evaluation of the Class EA covered by this approval, make appropriate revisions, and submit the revised environmental assessment for review under the Act by January 1st of the fourth complete year after approval.

The program EA (now referred to as Class EA) process has proved to be an effective way of ensuring that minor transmission projects are planned and carried out in a manner which is environmentally acceptable. The process has proven to be economical with respect to both time and money when compared with an individual environmental assessment.

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APPENDICES

1
Introduction

1.1 Class Definition

The class of projects (Class EA) covered by this document is defined to include the following:

1. The planning of, the acquisition of property for, and the design and construction of, a *minor* transmission line and/or a *minor* transformer station and/or a *minor* distributing station and/or a communication tower, and the subsequent operation and maintenance of these facilities.

   Minor transmission lines include all transmission lines longer than 2 km which:

   (a) Are capable of operating at a nominal voltage level no higher than 115 kV.

   (b) Are capable of operating at a nominal voltage level higher than 115 kV and less than 500 kV and which are shorter than 25 km.

   Minor transformer stations include those whose station's nominal operating voltage level is not less than 115 kV and not more than 230 kV. (Where a station has more than one voltage level, the highest level is used to determine whether or not the project is covered by this class definition.)

2. The planning, design and construction of a *minor* transmission line and/or a *minor* transformer station and/or a *minor* distributing station and/or a communication tower on property or property rights previously acquired, and the subsequent operation and maintenance of these facilities. Such property may have been acquired prior to proclamation of the *Environmental Assessment Act, 1975* or subsequent to that time but for a different specific use.

3. The planning, property acquisition, design and construction required to modify or upgrade a transmission line, and the subsequent operation and maintenance of the revised line where:

   (a) The work requires replacement of poles or towers (other than angle poles or towers) and/or changes in the right-of-way for *existing* transmission lines capable of operating at a nominal voltage level higher than 115 kV and not more than 500 kV.

   (b) The upgrading of existing lines would operate at a nominal operating voltage of 115 kV or higher and not greater than 500 kV.

4. The planning, property acquisition, design and construction required to modify or expand a transformer station, and the subsequent operation and maintenance of the revised station where:

   (a) An extension of the site is necessary.

   (b) The revised station is capable of operating at a nominal voltage level of not less than 115 kV and not more than 230 kV. (Where a station has more than one voltage level, the highest level is used to determine whether or not the project is covered by this class definition.)

1.2 The Undertaking

The undertaking, for which approval is hereby requested, is any project which falls within the class of projects defined above and which has been identified and deemed environmentally aocess described in this document.

1.3 The Rationale for the Class EA

The Class EA approach has proven to be an effective way of meeting the requirements of the *Environmental Assessment Act*.

The past four years have shown that the projects within the Class occur frequently, are small in scale, have a predictable range of effects and are able to utilize the same planning process.

Other alternatives shown below were examined to determine if they would better meet the requirements of the EA Act,

1. Individual EA's;
2. An exemption for the class of projects covered by the Class EA;
3. Individual exemptions;
4. A suitable combination of the foregoing.

Ontario Hydro's experience with individual EA's, exemption orders and the Class EA process has shown the Class EA process to be an effective way of ensuring that minor projects are planned and carried out in a manner which is environmentally acceptable. The process has proven to be economical with respect to both time and money when compared with individual environmental assessments. It was concluded also, that in addition to being an effective way of meeting the requirements of good planning, it also provided the best way of meeting the intent of the *Environmental Assessment Act*. This conclusion was confirmed by government ministries during the review of the Class EA. Members of the public have not specifically commented on the Class EA process, however, the project work undertaken to date has indicated that the process has been satisfactory.

Should an objection be raised on a future project, either by a government reviewer or a member of the public, the process ensures that the rights of the objector are protected. The Class EA process requires that any objection, filed during final notification, either be resolved or forwarded to the Minister of the Environment for a decision on the suitability of the process in dealing with that project. In some instances, Ontario Hydro may decide to proceed with an individual EA even though the physical parameters are suitable for the Class EA process.

1.4 Support Documentation

Reference is made in this document to the following:

1. *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities..*

   This document has a three-fold purpose:

   (a) To be used by design, construction and maintenance personnel of Ontario Hydro to minimize environmental changes.

   (b) To assist those involved in reviewing environmental assessments.

   (c) To provide information to the general public and to those specifically affected by transmission facilities.

2. *Protocol for Community Noise Control.*

   This document sets out the design philosophy and criteria applied to limit audible noise during construction and operation of Ontario Hydro facilities.

3. *Property Policies and Practices for High Voltage Transmission Line Rights-of-Way and Station Sites.*

   This document describes the policies and procedures involved in the acquisition of property rights.

2
Purposes of Projects Covered by the Class Definition

2.1 Transmission Line Component (Figure 2-1)

Any project within the class consisting, entirely or in part, of a new or upgraded transmission line, would have one or more of the following purposes:

1. To transmit electrical energy at a nominal voltage of 115 kV or above to an existing or proposed Ontario Hydro-owned or customer-owned transformer or distributing station.
2. To connect parts of the Ontario Hydro system, or to interconnect with neighbouring utilities, at a nominal voltage of 115 kV or above to improve the system's capability and/or reliability.
3. To strengthen existing connections between parts of the Ontario Hydro system at a nominal voltage of 115 kV or above.

NOTE: The transmission line component includes *new* transmission lines which would operate at a voltage of higher than 115 kV and not greater than 230 kV.

The upgrading of *existing lines* would operate at a nominal voltage of higher than 115 kV and not greater than 500 kV, but would *not* allow the nominal operating voltage level to be raised from 115 kV or 230 kV to 500 kV or above.

2.2 Transformer Station Component (Figure 2-2)

Any project within the class consisting, entirely or in part, of a new or extended transformer station, would have one or more of the following purposes:

1. To transform electrical energy from a nominal voltage of 115 kV or 230 kV to a subtransmission or distribution voltage of less than 115 kV, for distribution by a municipal utility or directly by Ontario Hydro to low-voltage customers. Where the transformation capacity is small, a station having this purpose *only* is usually referred to as a distributing station.
2. To transform electrical energy from a nominal voltage of 230 kV to a nominal voltage of 115 kV or vice versa, to interconnect parts of the Ontario Hydro system to improve the system's capability and/or reliability.
3. To connect together, or *bus*, sections of the Ontario Hydro system operating at nominal voltage levels of 115 kV or 230 kV, through automatic switching devices, to improve the system's capability and/or reliability. A switching station is a station having this purpose *only*.

2.3 Distributing Station Component (Figure 2-3)

Any project within the class consisting, entirely or in part, of a new distributing station which would serve the purpose of transforming electrical energy from a nominal voltage of 115 kV or 230 kV to a distribution voltage of 44 kV or less for distribution to Ontario Hydro's rural distribution electricity system.

2.4 Communication Tower Component (Figure 2-4)

Any project within the class consisting, entirely or in part, of a communication tower, would have the purpose of providing a suitable structure for supporting communication antennas. Communication antennas are used by Ontario Hydro for transmitting, receiving or *repeating* radio signals. The radio signals are used for the protection and control of the electric power grid and the facilities connected to it.

FIGURE 2-1
A Typical Transmission Line Application

FIGURE 2-2
A Typical 230 kV Transformer Station

FIGURE 2-3
A Typical 115 kV Distributing Station

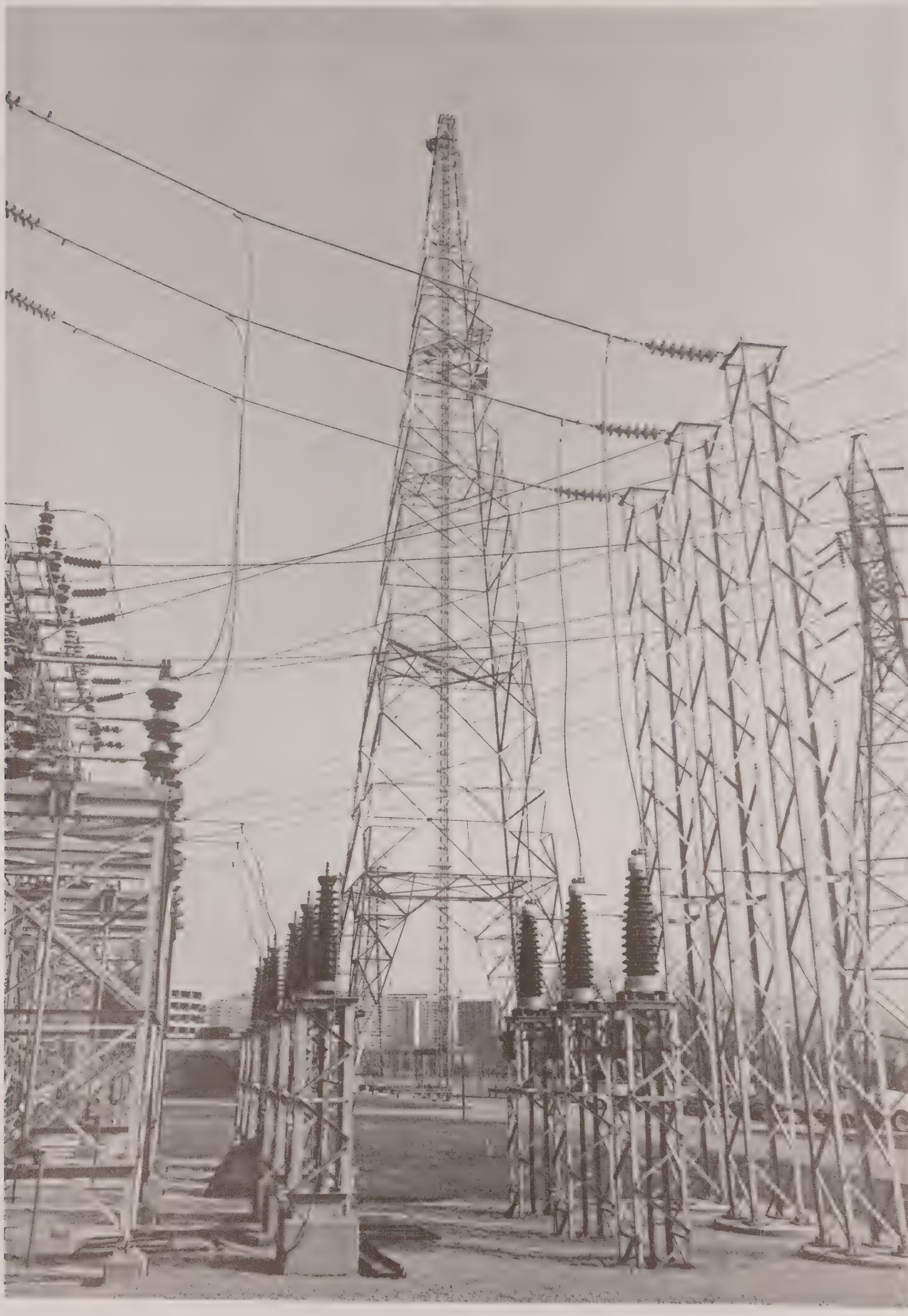


FIGURE 2-4
A Typical Communication Tower

3
Class Environmental Assessment Study Process

The study process which Ontario Hydro proposes to follow to establish whether or not any specific project can be considered environmentally acceptable is illustrated in figures 3-1 and 3-3 and is described in detail in this chapter. Figure 3-3 shows the process in detail. It must be emphasized that both figures show the maximum process but they also indicate certain *short cuts* that can be utilized and the conditions permitting their use.

3.1 Establish Need

It is the responsibility of Ontario Hydro to be continually aware of the extent to which recent past loads have taxed, and the extent to which anticipated future loads will further tax, the capabilities and limitations of the various transmission line and transformer station components which make up the Ontario Hydro system. This awareness comes primarily from routine planning reviews. These routine reviews are sufficient to indicate weak spots or areas of concern in the system. More detailed study must then be carried out to establish why, where and when the system will become inadequate and to determine the consequences of the inadequacy.

From time to time, specific information will become available from internal or, more usually, from external sources which will precipitate a detailed study of the adequacy of existing facilities in a particular area. Typically, such specific information might concern one of the following:

1. A new industry is proposed for a specific location.
2. A significant commercial and/or residential development is announced.
3. The actual capability of an existing facility is found to be less than anticipated.

The necessary detailed studies are then carried out in three stages:

1. Detailed data concerning the anticipated future requirements are prepared, e.g., load forecast.
2. Detailed data concerning the capabilities and limitations of the existing facilities are assembled.
3. Future conditions are studied using these data to establish when the existing facilities will become inadequate and what the consequences of the inadequacy may be.

3.1.1 Prepare a Study Load Forecast

Load forecast reports are prepared annually by Ontario Hydro. Each report includes details of the expected or *most likely* peak demands monthly for the current year and following year and for December only for the succeeding eight years for each of Ontario Hydro's *wholesale* customers. Included as *wholesale* customers at present are 321 municipal utilities, six regions divided into a total of 56 areas (see Appendix A) and 107 large (over 5000 kW) direct industrial customers. Appendix B, *Load Forecasting Considerations and Methods*, gives an explanation of why electrical load grows and how Ontario Hydro attempts to forecast this growth.

These load forecast reports constitute the starting point for most of the planning activity within Ontario Hydro. While designed to provide a consistent basis for this planning, sometimes the forecast data cannot be used directly in the form presented in the report. For example:

1. If the forecast data are for a large utility or area, they must usually be dissected or broken down into smaller components representing, for example, that portion to be supplied by a single transformer or distributing station, or part of a single transformer or distributing station, or that portion lying within defined geographical sections of the municipality or area.
2. If the detailed planning study contemplated includes all or parts of two or more municipalities and/or areas, the forecasts and forecast components for those customers must be combined into one (or several) comprehensive forecast(s).
3. In many cases the study must extend beyond the time period of the load forecast report. In these cases, the official forecast must be projected further into the future.
4. The forecast is given in kilowatts, the measure of the real power requirement of customer load. This must be converted to apparent power (kV·A) for the study, where apparent power is the product of the current and the voltage required by the load and includes the real power component and a reactive power component.

The methods used in carrying out these four steps are described in Appendix C.

As previously mentioned, the load forecast report indicates the most likely future load requirements. The usual practice in planning studies is to investigate the effects of other rates of load growth so as to establish whether or not and to what degree the need for new facilities and the nature of those facilities is sensitive to load growth.

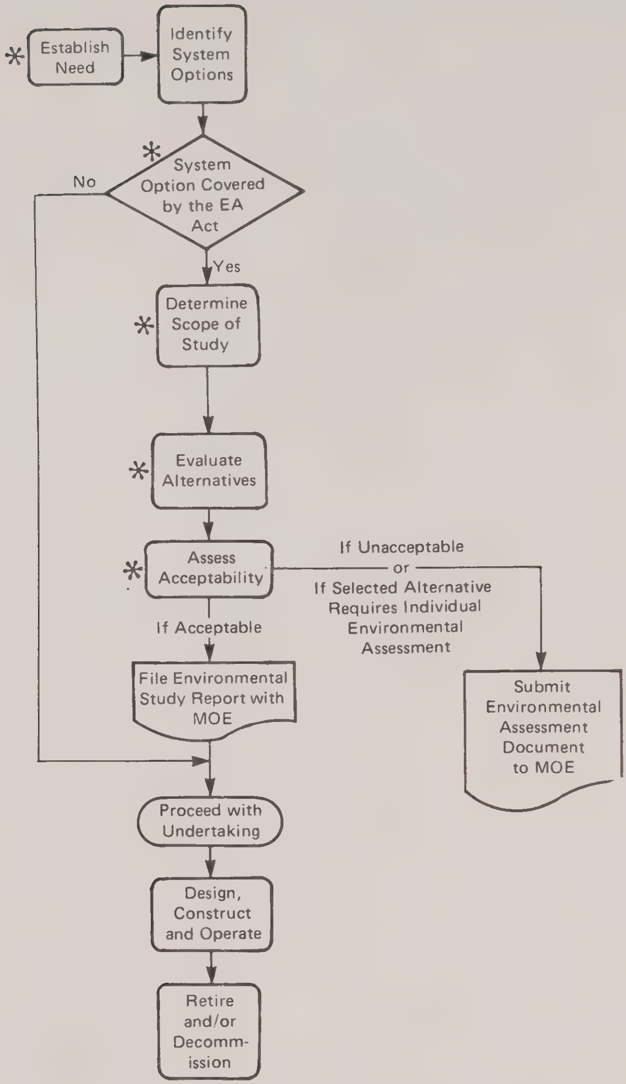
3.1.2 Prepare an Inventory of Existing Supply Facilities

For purposes of preparing an inventory of existing supply facilities, it is convenient to deal with the facilities under the following categories, opposite their function.

1. *Generation:* The total Ontario Hydro dependable peak resources in the winter of 1982/83 were about 21 652 MW. These resources included about 6436 MW (30 per cent) in hydraulic generating stations, 9827 MW (45 per cent) in fossil-steam (or *conventional thermal*) generating stations, 5248 MW (24 per cent) in nuclear generating stations, and 141 MW (less than 1 per cent) of combustion turbine generation. A further 3034 MW of generation resources were mothballed or frozen.
2. *Bulk transmission system:* The bulk transmission system (grid) is comprised of a network of lines operating at 500 kV, 230 kV and 115 kV which interconnect major generating stations and major transformer stations, the high-voltage switchyard portions of these stations and all 500 − 230 kV transformation.
3. *Regional supply system:* The regional supply system is comprised of the Ontario Hydro and customer-owned transformer stations and any 230 kV and 115 kV lines connecting these stations to the grid.

   It is expected that a majority of the undertakings covered under this document will consist of supply facilities within the regional supply category.
4. *Subtransmission:* The subtransmission system consists of 44 kV, 27.6 kV and 13.8 kV overhead and underground lines connecting transformer stations to Ontario Hydro or customer-owned distributing stations. The function of these lines is to transmit the power from the transformer station to distributing stations and to some individual customers.

The preparation of the inventory involves a detailed examination of the system components within each category. A checklist for carrying out this work is provided in Appendix D. Only items pertinent to the particular study are to be dealt with in the inventory.



*Denotes opportunities for public involvement.

FIGURE 3-1
Basic Class Enviromental Assessment Process

3.1.3 Carry Out Detailed Studies of Future System Conditions

Once the load forecasts and the inventory of existing facilities relating to any area of concern are prepared, system analyses will be carried out to establish the adequacy of those facilities to supply those future loads.

Principal Considerations Determining System Adequacy

There are six principal factors which must be considered in the assessment of an electric power supply system's technical adequacy:

1. *Thermal limits:* Each piece of electrical equipment has the capability to carry a specific maximum electric current continuously and, in most cases, larger currents for shorter periods of time (the shorter the period, the larger the current). If the equipment is required to carry more current than it is capable of carrying, damage will result. Depending on the magnitude of the overcurrent, this *damage* may simply reduce the life of the equipment or it may cause immediate failure. In the case of a transmission line, the overload must be limited to prevent the conductor from *sagging* to the extent that the clearance to ground or objects below the line becomes unsafe.

   An inadequacy which causes a slight reduction in the life expectancy of a piece of equipment could be considered acceptable under certain conditions. As an example, it would likely be acceptable where the overloaded equipment, if replaced with a higher rated unit, could not be used elsewhere.

2. *Voltage limits:* Every piece of electrical equipment is designed to operate within a specific voltage range. The effects of being forced to operate at voltages outside this range will depend on the type of equipment. An overvoltage applied to a resistive device (incandescent lamp, heater, etc.) could result in an overcurrent and shortened life or even thermal failure; applied to other electric equipment (motor, transformer, transmission line), it may cause insulation failure. An undervoltage could cause a motor to overheat or fail to start and a resistive device to be less effective, i.e., to produce less light (or heat) output. In particular circumstances, if the departure from the normal voltage range is not excessive or occurs infrequently, the consequences might be considered acceptable.

3. *Reliability:* Reliability is defined in general terms as the degree of continuity of full electric power supply delivered to the user's premises. Perfect reliability would mean that full electric supply is available 100 per cent of the time. There are six aspects of power interruption (or reduction) which may affect the user:

   (a) Frequency with which it occurs.

   (b) Usual duration.

   (c) Amount of advance warning.

   (d) Area or number of customers involved.

   (e) Time of day or year.

   (f) Cause.

   Power system reliability can be considered with respect to two aspects:

   (a) The first is *availability*, which is the probability that an individual element of the system (generator, transmission circuit, transformer, etc.) will be operable, i.e., not out-of-service due to a fault, equipment failure, incorrect operation or maintenance. Availability includes a consideration of the duration of each period of availability (or more usually of its converse, the duration of each period of unavailability) and the frequency of occurrence.

   (b) The second aspect of power system reliability is *security*. Security covers the ability of the system to withstand the sudden shock of the loss of one or more of the elements that comprise the system.

   Three levels of security can be considered for a supply to a transformer station:

   - Where the loss of one element only (a transmission circuit, a transformer, a generator, etc.) will result in the loss of load.
   - Where the loss of one element only will not result in the loss of load.
   - Where the loss of a second element with one already out of service will not result in the loss of load.

   Which level is to be applied in any situation will depend to a large extent on judgment.

   Availability is evaluated using probability mathematics. Security, because of its complexity, is evaluated by trial using a computer model of the system. The borderline between adequate and inadequate reliability is less than absolute. Ontario Hydro relies on guidelines established internally and in co-operation with the other interconnected utilities in the Northeastern United States for assessing the generation and bulk power system reliability.

   More information on reliability is available in several Ontario Hydro publications including the submission on Reliability to the Royal Commission on Electric Power Planning (RCEPP) with respect to the Public Information Hearings, dated May, 1976.

4. *Stability*: stability denotes the ability of the generators supplying a power system to remain in synchronism or to hold together through normal and abnormal system conditions. It is a very important consideration in the design and operation of a power system, and is therefore described in some detail in Appendix E.

5. *Protective co-ordination*: Most components of an electrical supply system are protected from damage by automatic devices which isolate the component quickly from the system in the event of abnormal conditions such as a short-circuit. These devices must be able to differentiate between what is a normal situation and what is an abnormal and potentially dangerous one. For instance, a device monitoring the current in a line must be able to differentiate between current swings due to normal load changes and those higher currents caused by a short circuit somewhere along the line.

   It is necessary to leave a margin between the maximum normal current which will not cause the device to operate and the minimum abnormal current for which it must operate. The consequences of reducing this margin are sometimes acceptable.

6. *Losses*: In any electric equipment or transmission line through which a current flows, there are electrical losses. Since the system generation must supply these losses as well as the load, the losses can be assigned a dollar value. Losses alone have seldom provided sufficient reason for declaring an electric supply facility inadequate. However, when considering, say, a long, heavily loaded subtransmission or distribution line, high losses combined with poor voltage and/or marginal protective co-ordination may result in an inadequate supply.

Methods of System Analysis

Up to about 20 years ago, system analysis methods included *slide rule* mathematical calculations and use of an electric analogue or model of the system. As power systems increased in size and complexity, analogues became impractical to use and today almost all complex analyses make use of high-speed digital computers. It is unlikely that it would have been practical to develop today's complex power systems if large digital computers had not been available.

A large number of computer programs are available to aid in the planning and operation of the power system. Some of the major programs used in system analysis are: load flow, tran-

sient stability, small-signal dynamic stability, short-circuit and transformer aging.

These programs are described in Appendix F.

3.2 Identify System Options

The same computer programs and planning expertise used to determine the inadequacy will then be employed to identify technically feasible methods by which the inadequacy could be overcome or deferred. These methods might include work by Ontario Hydro alone, by both Ontario Hydro and the municipal utility (or utilities) or direct customer(s) involved (system options), or by the utilities or customers alone (local options). While it is necessary that all of these options must satisfy the short-term problem, i.e., the inadequacy. They may or may not have the same long-range technical benefits. That is, one option may be good for three years before further inadequacies occur, another may be good for ten years, while a third may be good for three years but result in different inadequacies at the end of that time than would the first option. It is essential, therefore, that the development of the options to overcome the short-term inadequacy be carried out sufficiently far into the future so that additional stages of each can also be considered. The time period covered by the study must be from the date of the initial inadequacy, either to that future date when all options arrive at the same end result or to that future date when even major differences become insignificant in terms of the present worth of their costs.

Having established the technical options, rough comparative estimates will be prepared of the cost of all facilities (local and system) for all stages of each option. Using this cost data and suitable escalation and discount rate data, a gross economic comparison of the options will be made and any options which are obviously uneconomical discarded. Care will be taken in making any decision to discard an option at this time because relative environmental impacts will not yet have been considered. If the economics are not obvious and unequivocal, the option will not be discarded. Justification for discarding any option will be included in the study documentation.

3.2.1 Treating the *Do Nothing* Option

A decision would then be made as to the acceptability of the consequences of living with the inadequacy based on a comparative evaluation of the cost of alternative remedial measures against the cost of the consequences. It must be realized that this latter cost cannot usually be expressed in dollars. If the consequences are considered acceptable, the remedial work can be deferred. If the deferment is long enough that no further study is required at that time, the situation would be documented and scheduled for review at a subsequent date. If the consequences of the inadequacy are considered unacceptable, then the need to overcome (or defer) the inadequacy has been established. Environmental considerations are one of the factors which are considered in treating the *do nothing* alternative.

In the normal circumstances, this decision is made solely by Ontario Hydro, possibly with input from particularly affected wholesale customers. In certain instances, a customer may desire a supply which is more secure than that which would normally be provided to him. In such cases the customer would be required to pay the extra cost and the need for the extra facilities would be documented. If conditions change during the course of the study, this option will be re-evaluated. The Environmental Study Report will also address the option.

3.2.2 *Alternatives to* the Undertaking

The undertaking includes those transmission and microwave facilities as defined in Section 1.1, for the purpose outlined in Chapter 2 and described in Chapter 4.

For the purpose of examining *Alternatives to*, the undertaking will be divided into Transmission Facilities and Microwave Radio Communications.

The following alternatives are examples of those Ontario Hydro normally considers. Others may be evaluated in a case-by-case basis as appropriate, i.e., co-generation or conservation. This evaluation will include the net effects of both the alternatives to the undertaking and the alternative methods of carrying it out on the natural and social environment, including such environmental concerns as streambank erosion, visual effects, soil compaction, etc.

The *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* contains a general range of mitigative measures. The appropriate mitigation for a specific situation will be resolved on a case by case basis because of the importance of existing physical characteristics.

3.2.2.1 Transmission Facilities

Alternative Energy Technologies

The alternatives include solar energy, wind power and the use of wood or municipal solid waste to fuel boilers. These alternatives affect the environment in various ways. A brief description of the various alternative technologies follows:

Solar Energy

Two methods of generating electricity using direct solar energy are currently undergoing research and development in many countries, particularly in the United States. One method involves direct conversion of solar energy to electricity using photovoltaic cells. The other employs a direct thermal process where solar energy contributes directly to space heating of the house. This is known as "passive solar" heating.

The photovoltaic cell or solar cell is capable of generating electricity directly from sunlight. Currently, the cost of such a system is comparatively high and, in most cases, would not be a viable alternative.

Aside from the high cost, photovoltaic panels require roof tops or vacant land to contribute to electricity supply. It is estimated that an average of only 0.3 kW·h/m^2/day could be generated by photovoltaic cells.

The most promising future application of solar energy in Ontario may lie in "passive solar" space heating, which does not directly produce electric power. Depending on windows facing south and on house design, generally between 25 and 50 per cent of a home's total heating requirements could be met by solar energy. This being a specific design feature, it cannot be broadly applied. In addition, most heating requirements occur in winter when the daylight hours are short (seven hours) and the sun is at a low angle, therefore, supplementary heating systems are still required. The capital cost required for two systems is significant and, as a result, the possibility of implementation is small. Because of these factors, solar heating systems will not have much effect on Ontario Hydro's capacity requirements, but will still be considered on an individual basis.

Wind Power

In the past, many countries throughout the world have used windmills to pump water, grind grain and supply electricity for remote regions. In theory, the concept of wind power is simple; the wind turns the blades of a windmill, which drives a generator to produce electricity. The technology of harnessing wind power exists, and some individuals are using wind power on a small scale to supply their personal energy needs.

The low average wind speed in Ontario results in the need for large areas of land for windmills, and this poses a serious obstacle in using wind power economically on a large scale, especially in urban areas. To contribute to the generation of electrical energy, the windmill should be exposed to steady wind speeds averaging over 6 m/second. A wind turbine generator (WTG) does not supply energy on demand unless the energy generated is stored and that is expensive. The unpredictable and variable output of WTGs makes it necessary to provide a back up system to meet the demand during the period of calm and low winds. These economic, technical and land use problems, in addition to undesirable environmental effects such as noise and interference with TV signals, hinder the application of wind power for energy supply in Ontario. The mitigative measures are dealt with on a specific case by case basis since effects such as noise, TV interference, etc., are highly dependent upon the existing physical environment.

Burning Wood or Municipal Solid Waste

For economic reasons, the generation of electricity from both wood and municipal wastes tends to take place near the source of fuel. Wood fired generation is achieved in relatively remote locations. Energy from Waste facilities are located in or near urban areas.

The electricity generated from these facilities may assist in the solution of localized supply problems. The typical availability of electricity from an Energy from Waste plant is in the range of 80 per cent. During shutdown periods, the use of a transmission facility may still be required. This will depend on the area's dependence on this source of power and the availability of redundant equipment at the plant.

Also to be considered are the environmental implications from the burning of municipal waste or wood. If wood is used for large scale generation of electricity, it may have a significant impact on the transportation routes in the area. The siting of waste disposal facilities, including Energy from Waste plants, often cause concern to the citizens living in the immediate area. However, mitigation measures and a public review process are available to deal with any potential impacts to the environment.

Although economics usually preclude Energy from Waste as an alternative to a minor transmission facility, it should be considered when there is a local power supply problem. Ontario Hydro recognizes the potential societal benefits of an Energy from Waste facility in the overall context of municipal solid waste disposal programs. Therefore, if relevant municipal governments have specific plans to establish an Energy from Waste facility, then Ontario Hydro will give due consideration to such a facility as a solution to any identified electrical power distribution problem.

3.2.2.2 Microwave Radio Facilities

Radio telecommunications in the microwave frequency band are generally used for multi-channel, point-to-point communication. The disadvantages of microwaves are normally related to siting considerations. The distance between two adjacent microwave radio stations may vary from a few km to over 50 km depending on the operating frequency, tower height and the intervening topography. In order to reduce propagation loss between two stations, a line-of-sight radio path is required. In cases where the topography between two stations is too rugged and the line-of-sight radio path is obstructed, or the distance between the two stations is too great, a repeater station is installed between them to relay communications. This requires additional land. The *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* offers general mitigation and specific mitigation will be provided on a case by case basis. In most cases, these disadvantages will be outweighed by the advantages outlined below. The relative advantages and disadvantages will, however, be considered on a case-by-case basis.

Ontario Hydro presently has an operational microwave radio communications network in southern and part of northern Ontario, primarily for protection and control of the Bulk Electricity System (BES). The system operates in the 7 Gigahertz (GHz) band (7125-7725 MHz) which has been recently allocated by the Department of Communications (DOC) to all power utilities in Canada to be used on a primarily, but non-exclusive, basis for protection and control of electricity systems. The advantages of microwave are:

High Reliability – A microwave radio system can be engineered to provide extremely reliable communications by such techniques as route diversity, space/frequency diversity, use of hot standby equipment, etc.

High Capacity – A maximum radio frequency bandwidth of 19.5 MHz per microwave link is allocated in the 7 GHz band. Once the system is in place, up to 960 voice frequency channels can be accommodated easily and at relatively low cost if the proper intermediate frequency bandwidth in the radio equipment has been selected at the outset.

Interference-free – The 7 GHz is relatively free of interference from power line-related and other man-made noise sources. Although the band is shared with common carriers and the federal government for satellite communications, electrical utilities in Canada have been granted primary user status in this band by the DOC, thereby restricting other non-electrical utility users from placing new terrestrial services in this band.

Independence from Power Lines – Faults on power lines and system disturbances have no effect on microwave radio system.

Relatively Independent from Weather Conditions – Microwave radio systems operating in the 7 GHz band are not affected by rain or snow. Microwave radio links in excess of 50 km and traversing areas where propagation abnormalities are present can experience signal fading due to such factors as multipath reflections, refraction, ducting, antenna decoupling, etc. However, this problem can be remedied by using such techniques as frequency/space diversity or employment of additional repeater stations.

Costs – Capital costs are generally lower than those of cable communications systems except for short distances. A larger number of circuits can be provided than is technically and economically possible using power line carrier (PLC) systems.

Power Line Carrier

PLC systems utilize the physical paths formed by power lines interconnecting generating stations and load centres for transmission of information needed to manage and control complex electrical power networks. Generally, a PLC system consists of three distinct sub-systems:

1. The high voltage line that must provide a satisfactory bearer medium for the high frequency signals between the terminal stations;
2. The coupling equipment which serves as a means of connecting the carrier equipment to the high voltage line;
3. The carrier equipment which is comprised of transmitters, receivers, power supplies and associated components.

Power line carrier equipment has been utilized in Ontario Hydro for many years and is still being used in remote areas of the province. A prime example is in northern Ontario. This bearer medium is primarily used for protection, control and voice communications in a power system.

In protection applications, the signals transmitted over the power lines must be capable of operating correctly during power system fault conditions which may affect signal transmission. Similarly, the noise generated by a line fault or switching operations must not cause false operation. These difficulties can be minimized by proper system design and a more complex relaying scheme and by using appropriate coupling techniques.

A properly designed and implemented PLC system can offer reasonably secure telecommunications over a long distance at a relatively low cost, but channel capacity is limited due to frequency congestion.

There are some disadvantages associated with PLC communications and they are summarized as follows:

1. *Limited channel capacity:* This is due to the limited frequency band available and system congestion;
2. *Affected by environmental conditions:* PLC system performance may be degraded by weather conditions such as snow, sleet, icing and rain;
3. *Affected by power system disturbances:* PLC system performance will be degraded by line faults and equipment noise;
4. *Interference:* Potential interference from and to other licensed users operating in the same frequency band. A PLC system operating in the same frequency band and in close proximity to a licensed high-power radio station may be susceptible to interference from the licensed station. PLC systems are not protected by the Federal Department of Communications (DOC) which ceased licensing such sys-

tems some time ago. If a PLC system interferes with a licensed radio user, the PLC system has to cease operation immediately upon notification by the DOC. If no alternative frequency can be found, and the interference cannot be eliminated, then the PLC system must be taken out of service.

The present technology does not offer a feasible solution to the disadvantages discussed above, but will be examined on a case-by-case basis.

Fibre Optics

The basic operating principle of fibre optic telecommunications is that the information, usually in digital form, is converted to an optical signal which propagates from the transmitting end to the receiving end by bouncing between the inside walls of the glass fibre. At the receiving end, a photodetector is used to convert the modulated light signal back to its original electrical equivalent.

To communicate over a longer distance, repeater stations, which regenerate the signal and are typically spaced 30-35 km apart, are required in order to maintain reliable communications. This requires additional land. The *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* offers general mitigation and specific mitigation will be provided on a case by case basis.

In the past few years, many power utilities have installed fibre optic trial systems of 5-15 km length to evaluate the suitability of the medium for power system telecommunications, teleprotection and telecontrol functions. Over these short distances, the systems have provided satisfactory operation for power utilities. However, up to this date, no known long distance fibre optic system has been installed by power utilities in Canada for teleprotection functions.

Ontario Hydro has completed a fibre optic trial installation in the Toronto area between Fairchild TS and Leslie TS. The total distance is 5.2 km and the system is being evaluated for its suitability in power system applications. At the present time, this option is still experimental. The limitations, environmental effects and mitigation will be examined as experience is gained.

3.3 Determine Scope of Study

At this point in the study, the system options which warrant further consideration have been established. These options may have as their first stage:

1. A project which is to be implemented by the municipal utility or the direct customer.
2. A project which is to be implemented by Ontario Hydro but which is exempt from environmental assessment as per the Exemption Orders.
3. A project which is to be implemented by Ontario Hydro and which falls within the class of projects defined in this document.
4. A project which is to be implemented by Ontario Hydro and which is not exempt in any way from the full provisions of the Act.

If all of the remaining options fall under category 1, the utility/customer will be asked to carry out his own assessment of the options and to take appropriate action. If implementation of this local option will only defer the need for action by Ontario Hydro, the particulars will be filed and scheduled for review at a subsequent date.

If all of the remaining options fall under category 2, Ontario Hydro will proceed *in-house*, again providing for subsequent review if the chosen option defers more major facilities by only a few years.

However, the usual case will be that at least one of the remaining options is a category 3, or 4, project. If so, *all* options would be included in the environmental study which then follows.

3.3.1 Describe Facilities and Activities

Each option will be described in terms of:

1. The design and operational characteristics and requirements of the facilities usually required by such an option.
2. The specific procedures by which Ontario Hydro usually acquires property rights for and constructs, operates and maintains those facilities. For the class of projects covered by this document, such descriptions are given in Chapter 4.

3.3.2 Delineate Area to be Studied

A study area will be delineated to encompass the system options and the location of possible facilities required by each option. The boundaries of the study area will be established by considering the system options in relation to the occurrence of known potential major environmental impacts, technical constraints and obvious location options. The environmental constraints may take the form of: ecologically sensitive areas, e.g., rivers, lakes, wetlands; man-made constraints, e.g., highways, urban centres. Technical constraints may involve problems associated with construction and maintenance (e.g., flood plains, soil conditions) or interference with other facilities (microwave communication, radio transmission). Other boundary location opportunities may include such features as favourable property fabrics or existing severances. In some cases, the study process will include areas outside of the *identified study area* because of the potential for incurring off-site or indirect environmental effects.

3.3.3 Identify Environmental Factors[1]

The purpose of this stage in the study is to identify and attempt to avoid the more sensitive aspects of the environment. To do this, concerns about the environment which possibly could be affected by a proposed facility will be identified in the geographic area being considered for the possible location of facilities. The degree of detail both studied and reported will vary. The greater the potential significance of likely environmental effects of a specific project will determine the level of detail required to be studied. Generally, this would involve some or all of the following.

The concerns will be analyzed to determine which will be likely to be significant and then environmental situations[1], describing some specific environmental feature, process, condition, activity or combination of these which may be significantly affected by the construction, operation or maintenance of the proposed facilities will be developed. For each environmental situation that could be significantly altered by the proposed facility, an objective statement[1] will be written, which will predict the type and magnitude of the potential alteration to the environment. In addition, the objective statements will describe the present and future importance of each environmental situation to society.

Data on the geographical location of each of the environmental situations are collected, including where necessary some information from and about locations beyond the nominal study area.

Data collected and sources consulted will vary greatly depending upon the geographical location of the study area, available information and the project scope. The list provided in Appendix G is not a complete checklist but rather examples of environmental factors, situations and typical kinds of data types and sources used in carrying out an environmental assessment study.

3.3.4 Screening Process

At this point, the physical parameters of a proposed undertaking will be defined sufficiently to determine if the undertaking might qualify as a *Class* project. The environmental situations likely to be significantly affected by the proposed undertaking will be also known at this time.

Experience has shown that certain projects which appear to qualify as *Class* projects, i.e., have the correct parameters,

1. See Figure 3-2 and the environmental glossary contained in Appendix G.

actually cause such insignificant environmental impacts that they do not warrant the depth of study associated with the process described in this document. Examples of such projects are:

1. Additional wood pole structures along existing rights-of-way.
2. Extension to existing distributing or transformer sites.
3. Replacement or relocation of steel transmission structures.
4. Installation of switches in existing transmission lines.

However, projects such as these cannot be grouped together arbitrarily and carried out under an exemption order; because, in some cases there could be environmental situations present which would warrant a detailed study. If these situations are very significant and cannot be avoided, e.g., be highly controversial or there exists the presence of a rare or endangered species, the project will proceed as a class environmental assessment or may be undertaken as an individual environmental assessment.

A screening process has therefore been developed to screen out proposed projects which would cause environmental impacts so slight as to be of no concern.

Ontario Hydro will use the screening process in consultation with directly affected government ministries, agencies, conservation authorities, special interest groups and the public in order to identify environmental concerns.

The criteria used in the assessment consists of a set of questions which, if answered "no", will allow the project to proceed without further study. If any of the questions are answered "yes" or "possibly", then the project will follow the study process described in this document. The following provides a minimum list of criteria. Other factors will be considered if a potential concern is identified.

General Criteria

Determine whether the proposed undertaking will:

1. Conflict with the environmental goals, objectives, plans, standards, policy statements or guidelines adopted by the Province of Ontario or the community where the project is to be located.
2. Have significant effects on persons or property.
3. Necessitate the irreversible commitment of any significant amount of nonrenewable resources.
4. Pre-empt the use, or potential use, of a significant natural resource for any other purpose.
5. Result in a significant detrimental effect on air or water quality, or on ambient noise levels for adjoining areas.
6. Cause significant interference with the movement of any resident or migratory fish, wildlife species, or their respective habitats.
7. Establish a precedent or involve a new technology, either of which is likely to have significant environmental effects now or in the future.
8. Be a precondition to the implementation of another undertaking.
9. Likely to generate significant secondary effects, directly caused by Ontario Hydro's activities, which will adversely affect the environment.
10. Block pleasing views or significantly affect the aesthetic image of the surrounding area.
11. Significantly change the social structure or demographic characteristics of the surrounding neighbourhood or community.
12. Overtax existing community services or facilities (e.g., transportation, water supply, sanitary and storm sewers, solid waste disposal system, schools, parks, health care facilities).
13. Result in undesired or inappropriate access to previously inaccessible areas.
14. Create the unnecessary removal of timber resources.
15. Result in significant detrimental effects to man-made or natural heritage resources.

Specific Criteria

Determine whether the proposed undertaking will:

1. Involve obtaining property rights for an additional area of 4 ha or more to accomodate the expansion of existing transmission or transformer/switching station facilities.
2. Involve installation of more than 10 new wood pole transmission structures.
3. Involve, on existing rights-of-way, installation of more than five new steel transmission structures.
4. Involve relocation, for Ontario Hydro's purpose, of more than 20 wood pole transmission structures or more than 10 steel transmission structures.
5. Involve the replacement of more than 20 foundations for steel towers.
6. Involve the relocation of transmission facilities located on land owned or leased by public or private interests at the request of the property owner.
7. Deviate substantially from the type of projects which have been described in Appendix H.
8. Involve the construction of a new access road longer than 5 km.
9. Involve obtaining the property rights for the construction and operation of a 115 kV distribution station which would:
   (a) Require more than 1 ha for the site and related facilities.
   (b) Require egress from the station by way of overhead feeder lines.
   (c) Be located in an area which has been zoned for residential development.
   (d) Be of the high-profile design having a maximum structure design exceeding 7 m.

3.3.5 Initial Notification

As shown on the schedule in Appendix I, the provincial ministries will be notified of the system need, the options and the area that Ontario Hydro proposes to study. Each ministry will be asked to comment with respect to ministerial policy in connection with the proposed options and study area. Appendix I also contains the requirements for notifications as of January 1, 1984.

Coincident with contacting the provincial ministries, Ontario Hydro will:

1. Publicly announce the project.
2. Notify each potentially affected local, county, regional, district and metropolitan municipality, and identify any of its official plan policies concerning environmental matters that may be affected by the project (such municipalities are to be considered as part of the "public").
3. Where the study area includes any part of the area under the jurisdiction of the Niagara Escarpment Commission, notify the Commission and take account of any features of the Niagara Escarpment Plan.
4. Notify any conservation authority which has jurisdiction over watersheds that may be affected by a project.
5. Include amongst the specific public groups which may be invited to take part in Ontario Hydro's external working committee for a project, a group concerned with the protection of heritage resources, where one exists.

The initial notification given to the potentially affected and interested public and provincial agencies shall contain information on the system need for the proposed project, the options available, the area that Ontario Hydro proposes to study and the rights given to the public under this Class EA approval, includ-

ing the bump-up provision, or advice as to how this information may be obtained.

In some cases, early consultation will reveal that two separate notifications are not required since there have been no concerns identified.

If, after consultation with interested or potentially affected parties, there persist little or no public concern, a decision will be made to issue a single notification containing all the elements normally described in both the initial and final notification.

Initial notification will occur as early in the study process as is reasonable.

This notification will be issued upon the selection of the preferred alternative as shown in Figure 3-3.

3.3.6 Scope of Study Document

A document describing the scope of study will be drafted. It will include the following:

1. A discussion of the need.
2. A description of, and justification for, each of the system options to be considered.
3. A description of the environmental analysis which will be carried out in the study process.
4. A description of the proposed study area.
5. A discussion of the process by which the public will be involved.
6. A schedule for the study.

Contents of the draft document will be discussed with the ministry representatives and the public and modified if considered necessary. The document will then serve as the terms of reference for the study.

3.4 Evaluate Alternatives

Once the study area has been delineated, the problem will become one of analyzing and evaluating the environment of the study area, culminating with the recommendation of a preferred alternative. This will be accomplished by the step-by-step elimination of less acceptable alternatives as illustrated in Figure 3-3.

The five distinct steps which comprise the elimination process are as follows:

1. Environmental data will be collected and mapped from various sources for the delineated study area (and beyond the study area if necessary).
2. The location of the environmental situations plus value judgments on their importance and a description of the possible effects of the proposed facility will be prepared in order to produce constraint map(s) (as illustrated by Figure 3-2).
3. Using the constraint map(s) as a basis, the location(s) for facilities will be identified for each alternative, aiming to create the least impact for each.
4. The degree of potential environmental changes and their implications, for each alternative, are identified and their relative impacts are evaluated. Also included in the evaluation are any environmental changes not identified by the constraint mapping approach. Net effects will be considered on a case by case basis. Typical examples of potential mitigative measures are described in Appendix K.
5. The evaluation results are compared and, according to a combination of facility suitability and environmental effects, a preferred alternative is selected for recommendation.

In addition to environmental considerations, technical limitations will be identified and a cost analysis will be performed for each alternative. Generally, the technical restraints will have the largest impact upon the cost of an alternative. For example, the shortest distance of a transmission line will not necessarily yield the least cost should the crossing of rivers or marshland be required. Further examples of the typical criteria which will be used in the selection of a distribution station site or transformer station site are as follows:

1. Soil resistivity should be low.
2. The area should be fairly level and well drained.
3. Areas which consist predominantly of rock, silt or unstable soils should be avoided.
4. Ingress of high-voltage circuits should be practical.
5. Egress of underground low-voltage circuits should be practical.
6. There should be no buried services on the site (i.e., telephone or gas pipeline).
7. The site should be located so that it can be serviced by an all-weather road.

   For transformer station sites, a heavy load transportation capability of 200 t (gross weight), a minimum overpass clearance of 8 m and close access to rail service is required. In addition, bridges should be avoided on the heavy load access route.

   Distributing station sites require a heavy load transportation capability of 45 t.

   For both distributing and transformer station sites, all curves must have a large turning radii and all grades should be less than 5 per cent.
8. In selecting the site, consideration will be given to the noise protocol between Ontario Hydro and the MOE, municipal regulations, official plans, zoning bylaws and heavy load transportation restrictions.
9. The property adjacent to the site should be free of overhanging trees or structures and should not pose potential fire hazards.

3.4.1 Public Involvement

It should be noted that the method by which each step is executed may differ from study to study, having been developed and publicly reviewed as part of establishing the study scope.

Individuals identified at the outset as external or public participants will be provided ample opportunity for active participation in each step. This will be accomplished through an iterative process whereby information (collected in part from the public) is incorporated by Ontario Hydro. The result is subjected to review by the external participants, and modifications, if required as a result of the review, are made in turn by Ontario Hydro. This process ensures that public concerns are given full and fair consideration, each step is understood, and the results of each step are generally acceptable.

The structure of the public involvement program will vary depending on the scope of the study and its geographical location and extent. In all cases, an attempt will be made to identify the concerns of the people living in the area being studied and to avoid, if possible, those environmental impacts which they consider would cause lasting damage ecologically, socially or economically.

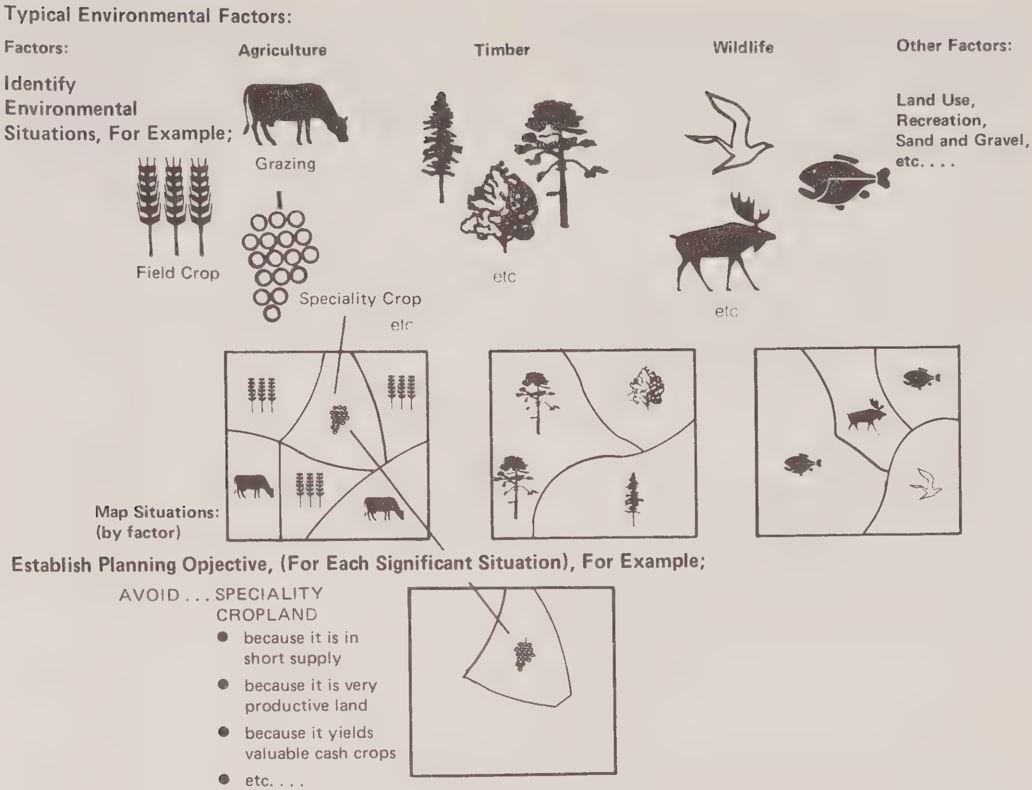
One of the ways this has been accomplished in the past has been to form an external working committee consisting of individuals from the study area who represent organizations or groups having specific concerns or interests. This committee would be involved throughout the study.

Generally, projects involve the public through information centres open to the general public and are often used to display and discuss such things as the scope of the study, the system options, and the alternative selected. Newsletters over the life of the study are also used to ensure that the public is informed and has the opportunity to comment on the study.

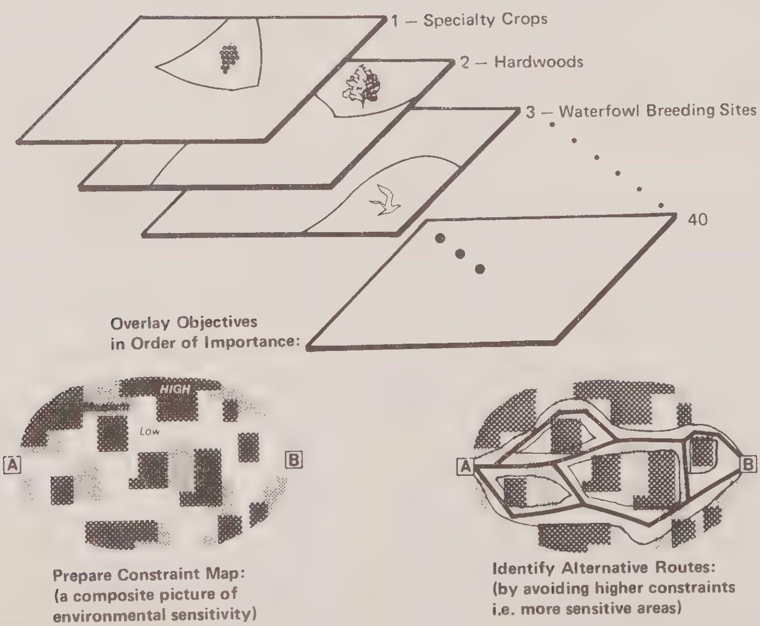
3.5 Assess Acceptability

3.5.1 Final Notification

Ontario Hydro shall give final notification to the provincial ministries and agencies which have indicated a continuing interest in the project and the directly affected and interested public. Final notification to the directly affected and interested public will be carried out by direct mail or some other form of personal type service. The notification shall include:



Constraint Mapping I:
Describing Environment and Impacts



Constraint Mapping II:
Compiling Constraint Map

FIGURE 3-2

1. A description of the selected project.
2. Advice that comments on the selected project should be received within 30 days by a specified person in order to receive consideration.
3. Advice that environmental study information is available for inspection at specific locations.
4. The rights given to the public under this Class EA approval, including the bump-up provision, or advice on how this information may be obtained.

3.5.2 Assess Acceptability of Selection

If there has been no expressed opposition, the selected project will be considered acceptable. If it falls within the class definition, it becomes an undertaking as defined by this Class Environmental Assessment Document. Approval of the selected project under the EA Act is granted in accordance with the approved Class EA. Ontario Hydro may then apply for an Order-in-Council under the Power Corporation Act for property acquisition and/or construction of the facilities.

If there is expressed opposition to the selected project, Ontario Hydro will re-evaluate the rationale for the selection in light of the opposition. If the re-evaluation and subsequent modification satisfy the specific opposition and result in no further opposition, then the project will be considered acceptable and will become an undertaking. If re-evaluation does not eliminate all expressed opposition, Ontario Hydro may decide that the expected impacts are unacceptable and the project may require an individual environmental assessment.

3.5.3 Review and Decision by the Minister of the Environment

In the event that Ontario Hydro cannot satisfy all objectors, but still considers the expected environmental impacts to be insignificant and acceptable, the written objection along with Ontario Hydro's response will be forwarded to the Minister of the Environment for a decision as to whether or not the project requires an individual environmental assessment. A copy of the letter to the Minister of the Environment and Ontario Hydro's response will be sent to the objector(s) at this time.

1. After considering the objection and Ontario Hydro's response, a decision will be made by the Minister of the Environment, normally within 30 days.
2. If the decision reached indicates that the objection does not warrant an individual environmental assessment for the project, the Minister of the Environment will inform both parties and the project may then proceed.
3. If the decision reached is to bump-up the project, then the objector and Ontario Hydro would be provided with the rationale for requiring an individual environmental assessment. Ontario Hydro would then be required to submit an individual environmental assessment or withdraw the project. Should the objection(s) be resolved and Minister of the Environment agrees, the planning process will resume at the point where the objection occurred.

Ontario Hydro will attempt to identify concerns as early as possible in the study process in order to maintain maximum flexibility to resolve any such concerns during the study process.

3.5.4 Environmental Study Report

An Environmental Study Report (ESR) will be prepared for each project subjected to the study process described in this document. Upon completion of the environmental study, copies of the ESR will be filed with the Ministry of the Environment, elected and appointed officials, and also forwarded to Ontario Hydro's area office. A copy of the ESR will be made available to anyone who requests it.

Prior to filing the ESR, the information will be available for review by any interested party during the period of final notification. The information will normally consist of the following:

1. A description of the undertaking.
2. A description of, and the need (justification) for the project.
3. The location of the selected project.
4. The expected effects on the environment.
5. The way in which the impacts were evaluated.
6. The alternatives, mitigation proposed and predicted net effects.
7. A description of any required environmental monitoring.

If concerns are raised on either the study process being followed or the project itself, they will be noted in the ESR.

3.6 Subsequent Communication with the Public

The acceptance of a selected project under this process does not end communications between Ontario Hydro and the public.

Provisions for subsequent communication with individuals whose property is affected by an undertaking are detailed in Appendix J.

3.7 Decommissioning

When transmission facilities become obsolete or unserviceable, the equipment is retired from service. The facilities may be removed and the site made suitable for some other purpose. When transmission structures are removed from farm land, the foundations are cut back 0.5 m below groundline in order to eliminate any obstruction to farming operations.

The disposition of rights-of-way and station sites would be in accordance with Section 3.8, "Land Surplus to Ontario Hydro Needs".

Treatment of abandoned station or tower sites will be in accordance with *Environmental Guidelines for Construction and Maintenance of Transmission Facilities*.

3.8 Land Surplus to Ontario Hydro's Needs

Any land acquired which is surplus to the needs of Ontario Hydro may be disposed of by sale. Ontario Hydro offers such land to former owners, adjacent owners, public utilities, government and government agencies prior to offering it to the general public. Sales to the general public will vary depending on circumstances and may be through public tender, real estate broker, auction or direct sale. In the event a severance is required, prior to the sale of such lands, Ontario Hydro will consult with affected municipalities pursuant to an operational policy covering the subdivision of lands under the Planning Act.

In the event the surplus land is not sold, Ontario Hydro will continue its normal land management responsibilities.

3.9 Monitoring

Ontario Hydro has been monitoring the effectiveness of the *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* on transmission projects with both station and transmission line work which have had either an individual or class environmental approval and on which field work started after the 1st of January, 1981. Details of the monitoring program are contained in the guidelines.

3.10 Addendum to an Environmental Report

Occasionally, a project which has been undertaken under the class environmental assessment process requires modifications following the filing of the Environmental Report. These minor modifications are generally as a result of conditions beyond Ontario Hydro's control. In such cases, an addendum will be prepared which gives details of the revision and the final notification phase (Section 3.5.1) will be repeated. If no expressed opposition is received, the addendum will be filed with the report and the project may proceed. If unsatisfiable opposition is received, then the process as described in Section 3.5.3 will be followed.

3.11 Amending this Class Environmental Assessment Document

Ontario Hydro may apply for amendments to this Class EA at any time for the purpose of:

1. Clarification of any portion of the assessment; or

2. Improving either the efficiency or the effectiveness of the process described in the assessment.

In order to facilitate the above, the following three-step process will be followed:

1. The change will be described in detail, justified with additional support material as necessary and submitted to the Minister of the Environment for his consideration.
2. The minister will review the information presented and, if satisfied that the request is reasonable, will issue a notice to the public as well as any potentially affected provincial ministry, agency or municipality, and allow 30 days for comments.
3. On the basis of comments received, the minister will decide if the suggested ammendment should be incorporated.

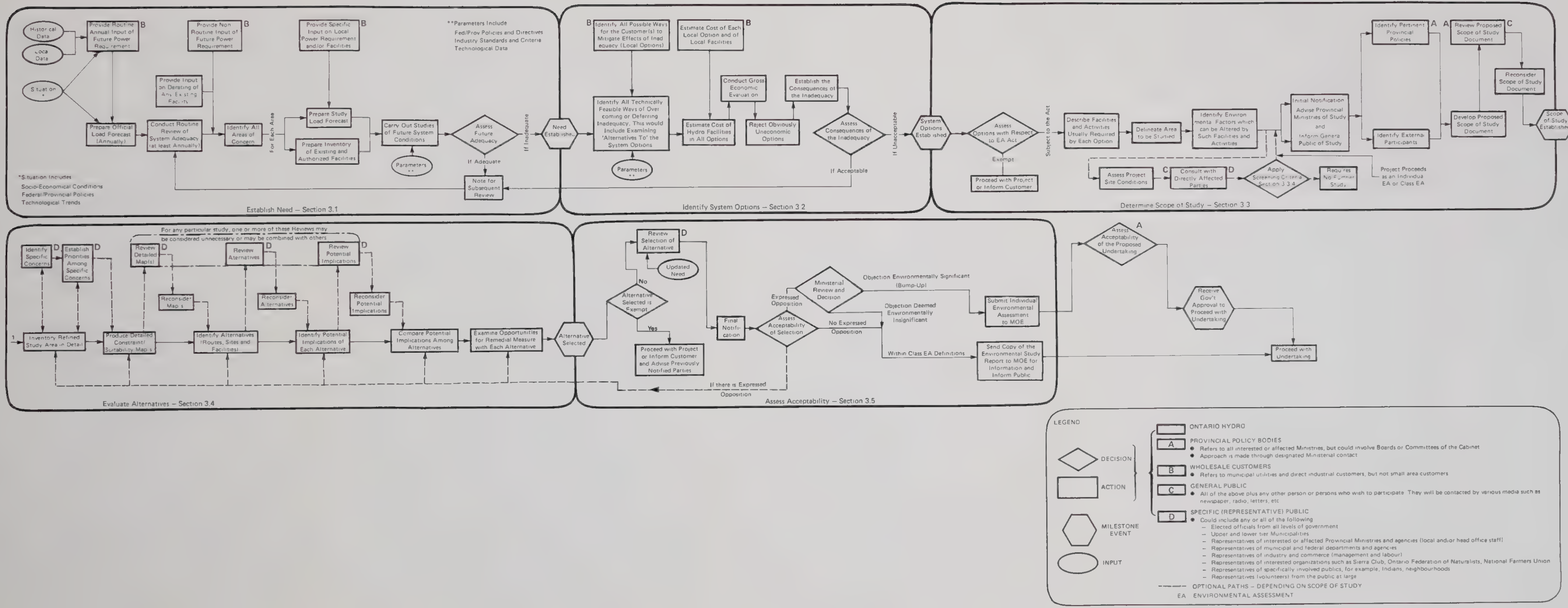


FIGURE 3-3
Detailed Class Environmental Assessment Process
– Refer to Chapter 3

4
Description of Projects Covered by the Class Definition

This chapter describes the physical components and activities associated with the projects covered by this assessment.

4.1 Transmission Lines

Ontario Hydro usually transmits electrical energy via overhead lines, except in densely populated areas where underground transmission lines may be used. The decision as to which will be used for a specific undertaking is dependent on the overall environmental implications of each.

4.1.1 Overhead Transmission Lines

An overhead transmission line has six basic components, each of which may vary with respect to design and material depending on the specific requirements for the line and its intended location. The components, along with their function and material options, are as follows:

1. *Conductors*: To provide continuous electrical pathways (circuits) between points of supply and use. Stranded aluminum steel-reinforced, stranded aluminum, stranded copper.
2. *Skywires*: To shield conductors from lightning and carry fault current. Galvanized steel, copperweld, alumoweld.
3. *Structures*: To support conductors at a safe elevation above ground. Steel lattice, steel pole, wood pole.
4. *Foundations*: To support structures. Steel grillage, reinforced concrete, steel or wood piles with suitable cap.
5. *Insulators*: To isolate conductors electrically from their supporting structure. Porcelain or glass.
6. *Counterpoise*: To reduce the susceptibility of the line to outages caused by lightning. Galvanized steel, copper.

Transmission lines in Ontario usually consist of aluminum conductors steel-reinforced, galvanized steel skywires, steel lattice structures, reinforced concrete foundations, procelain insulators and galvanized steel counterpoise wires. Figure 4-1 shows a span of a typical line and identifies its component parts.

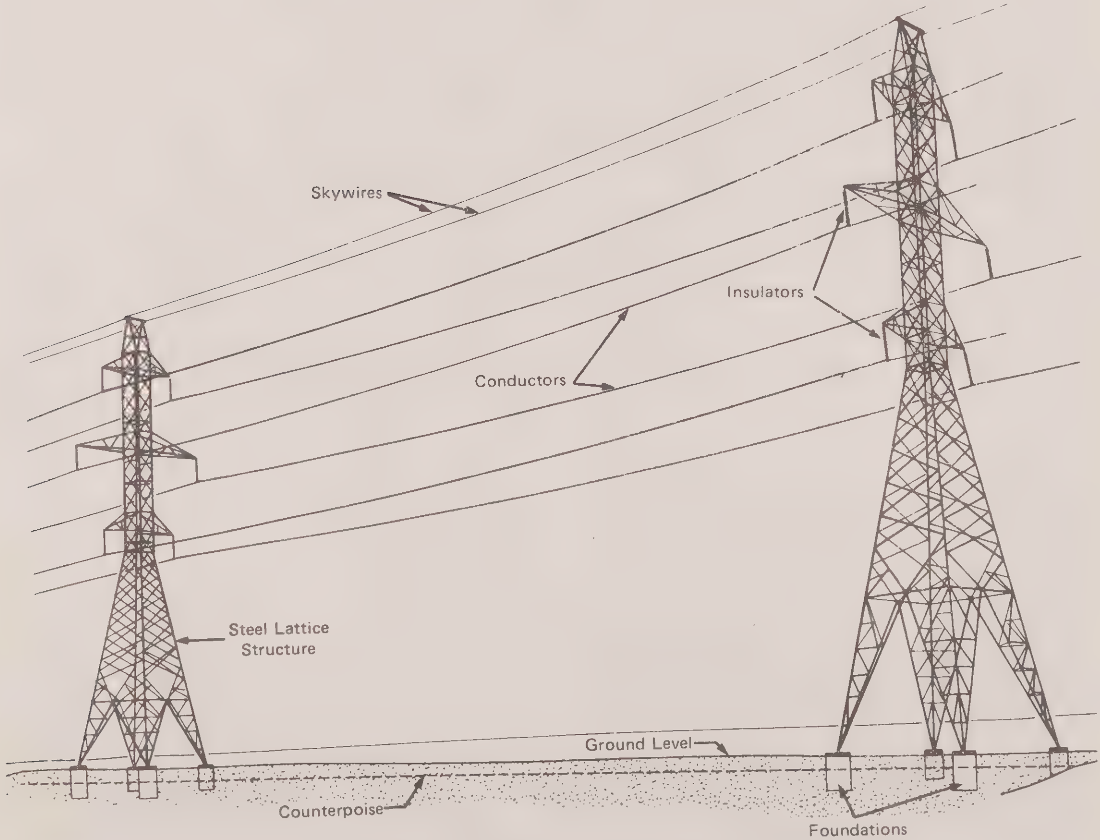


FIGURE 4-1
Component Parts of a Typical Transmission Line

Right-of-Way Requirements

A typical right-of-way width to accommodate a two-circuit 230 kV tower line is shown in Figure 4-2. The actual widths required for specific rights-of-way vary because of such factors as span length, conductor size and sag, the location of danger trees, the need for helicopter patrol or the need for fall-free spacing.

Right-of-Way Acquisition

Rights-of-way for transmission facilities are acquired in accordance with the policy established for property acquisition. Under this policy owners are given the full protection of the Expropriations Act. Easement rights are generally acquired for transmission line rights-of-way except where the fee (full ownership) is required by Ontario Hydro or where a severance is acceptable to the municipality.

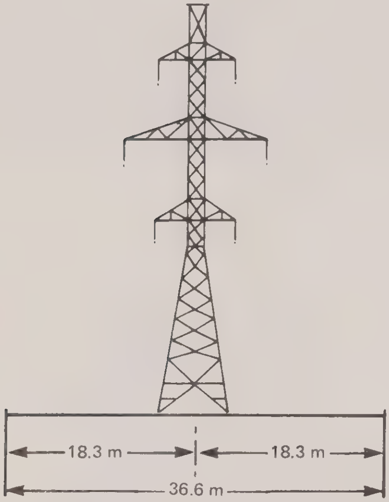


FIGURE 4-2
Typical Right-of-Way Width for a 230 kV Two-Circuit Transmission Line (Narrow-Base Single Footing Towers may be Used in Cultivated Fields of Prime Farm Land)

Construction Activities

The major operations in the construction of overhead transmission lines include the selective cutting of trees along the right-of-way, establishment of construction access routes, the installation of tower foundations, the assembly and erection of towers, the stringing of conductors, the installation of counterpoise, and clean-up and restoration of the right-of-way. Construction may be carried out either by Hydro's construction staff or by contract forces. Construction practices will comply with those described in the *Environmental Guidelines for the Construction and Maintenance of Transmission Facilities* approved by the Ministry of the Environment.

As part of the guidelines, specific instructions may be issued where environmentally sensitive situations are identified through the planning or construction phases as set out herein. In such cases, the specific instructions will govern.

Access routes: To construct a transmission line, it is necessary to have access to the right-of-way for the construction equipment and line materials. Wherever possible, existing roads and lanes are used and resulting damage is repaired when construction activities are completed. Where access roads for Ontario Hydro vehicles have to be constructed, their location is determined by Ontario Hydro in conjunction with the concerned owners and applicable authorities, e.g., conservation authorities, Niagara Escarpment Commission or others. The environmental impacts caused by access roads will be considered as part of the study.

Tower foundations: The type of foundation installed at any given site is dependent on both the type of soil and the type of tower to be built. Soil tests are carried out to determine soil strength for foundation designs. The majority of foundations in earth will be augered reinforced concrete. In weak soils, piles may be required. Those in rock will have steel rods drilled and grouted into the rock and a small pad of concrete placed on top. Foundations for towers which will be used at angle or terminating positions are larger than those required for suspension towers.

Equipment such as augers, backhoes, concrete trucks and compressors may be used in foundation construction. Excavated material is either removed from the site or spread in a suitable location.

Tower assembly and erection: Tower steel is delivered via the access routes to the sites where it is assembled to form tower sections which are usually lifted into position by a crane.

Conductor stringing: The stringing of conductors can be done in two ways: *slack stringing* in which the conductor is pulled along the ground and placed in travellers at each tower before being tensioned, or *tension stringing* in which the conductors are pulled under tension through travellers (pulleys) attached to each tower. Being under tension, the conductors are kept off the ground at all times. The first step in tension stringing is to install the insulator strings and travellers on the tower arms. That is followed by installating a light rope along the section of line to be strung; stringing sections can be as long as 10 km. A helicopter is normally used to fly the rope along the right-of-way for deposit in the travellers. This rope is then used to pull in larger ropes and steel cables until one of sufficient strength has been strung to pull through the conductors.

After all the conductors are pulled into place by this method, they are tightened to a specified tension. This tension ensures that the line maintains the correct ground clearance under the operating conditions for which the line is designed. The conductors are clamped at each tower and damping devices are installed on them to limit vibration. Skywires are attached at the tower peak positions above the conductors and are strung in a similar manner.

Specialized equipment is required for tension stringing. The equipment is moved along existing roads wherever possible, thus avoiding the need to move heavy equipment along the full length of the right-of-way.

Counterpoise: To ensure that a transmission line will operate efficiently when in service, it is necessary that the electrical ground resistance at each tower be low. To accomplish this, a ground electrode is installed at each tower. If, because of soil conditions, the ground resistance is too high, additional grounding must be installed.

The normal procedure is to bury two continuous wires along the right-of-way, one on each side of the towers. These wires are normally buried to a depth of 460 mm in cultivated ground and 200 mm in bush areas and in rocky ground, if possible. The wires are installed by a tracked vehicle which carries the ground wire on reels and buries it by means of a plough attachment as it proceeds along the right-of-way. The wires are then connected to each tower.

Clean-up: The final stage of construction is the clean-up of the right-of-way to be sure that all construction materials have been removed. This is an ongoing procedure during the construction of the line, but a final clean-up is also carried out. In addition, any necessary restoration to the right-of-way (i.e., work sites, fences, roads, etc.) is completed and the woodlots are seeded. All erosion sites are stabilized and screen plantings are established as required on the right-of-way.

Transmission Line Maintenance

Maintenance of transmission lines is required to prevent uneconomic deterioration of the line components with time and to repair damage due to accidents or unusual climatic conditions. This involves periodic patrols and/or inspections. Specific maintenance programs have been developed and are carried out on a regular basis.

Routine maintenance: Planned repairs of a localized nature which usually take over one-half to one day to complete are carried out to avert potential problems. These repairs may require trucks to be moved to the repair site. The frequency of such repairs is approximately once each year for every 160 km of line.

There are also major maintenance items such as replacement of skywire and the lowering of tower footing resistance along a line. These items are usually of such a nature as to permit long-range planning, and they can usually be scheduled to minimize incovenience to property owners.

Emergency maintenance: Emergency repairs must be carried out as quickly as possible. It may take one-half to one day to replace a string of broken insulators or several days to replace structures damaged by ice storms or tornadoes. Heavy equipment and materials are usually required to replace structures during emergency situations, and mitigating measures will be taken as soon as possible to repair any damage.

Right-of-Way Management

Right-of-way management practices reflect provincial and legislative requirements and are designed to ensure the long-term safety and reliability of the line and protection of the environment.

The management practices are carried out in accordance with general and site-specific management specifications which identify the best treatment methods.

Management Activities

Line Clearing: Involves the pruning or removal of woody vegetation near the conductors so that a specified minimum clearance is maintained.

Patrols: Inspections done at regular intervals to identify and correct situations which cannot be left until the next regular maintenance operation.

Grounds Maintenance: Includes activities such as grass cutting, weed spraying and snow ploughing done in order to keep Ontario Hydro properties in a visually acceptable and safe condition.

Vegetation Control: Involves the control of woody vegetation in order to ensure that circuits are not interrupted and public safety is maintained. Methods currently used are herbicides, hand cutting, and machine mowing. Selective removal of incompatible woody vegetation is practiced to promote the development of low growing stable plant communities.

Stabilizing or Restoring the Environment: Erosion sites are identified and controlled by vegetative or mechanical methods.

Secondary Use of Ontario Hydro Property: Secondary use requests are granted when practical, where they do not cause conflict with the adjacent property owners, and where they will not interfere with Ontario Hydro's use or projected use of the right-of-way or endanger any facilities. A Procedural Document has been prepared in accordance with the *Environmental Assessment Act* whereby secondary land use proposals are assessed. Garden plots, access roads to cottages, horseback riding trails, parking lots, utility pipelines, etc., are some of the secondary uses of Ontario Hydro rights-of-way that may be permitted and where agricultural use is possible, it is encouraged.

4.1.2 Underground Transmission Lines

Physical Plant Options

Self-contained, low-pressure, oil-filled cable: Each underground circuit consists of three separate cables, each consisting of a concentric stranded copper or aluminum conductor with a hollow core, insulated with paper tapes and sheathed with either lead or aluminum. After sheathing, the cable insulation is thoroughly dried under vacuum to remove moisture, and the cable is then filled through its hollow core with a degassed oil which fills any voids which might exist in the insulation. Oil reservoirs which exert a slight positive pressure on the cable oil are connected to the cable. The cable sheath is protected against corrosion by a suitable covering. When the cable is heated by current flowing through it, the oil expands and flows through the hollow core to the reservoirs at the cable terminals. When the cable cools and the oil contracts, it is forced back into the cable by pressure on the reservoirs. Thus a positive pressure of moderate magnitude is kept on the oil at all times, preventing the formation of voids in the insulation which could ionize under electrical stress and result in breakdown of the cable insulation.

Self-contained, low-pressure, oil-filled cables can be directly buried without being encased in either a duct or pipe. It is, however, necessary to surround the cables with a material which will permit uniform heat dissipation along the length of the cable to reduce the probability of hot spots developing and permit optimum utilization of the current-carrying capacity of the cable. Ontario Hydro usually surrounds directly buried high-voltage cables with an envelope of finely crushed stone. These cables are protected against mechanical damage by concrete slabs placed over them.

Self-contained, low-pressure, oil-filled cables installed in ducts: These cables are identical to those used for direct bury, but instead they are installed in cable ducts which are encased in concrete. Cable splices are contained in permanent reinforced concrete manholes which are positioned along the route at suitable locations.

High-pressure, pipe-type cable: This type of cable relies on high pressure acting on the cable insulation to supress the formation of voids which could ionize and result in electrical failure of the insulation. The cable consists of a stranded copper or aluminum conductor insulated with oil-impregnated paper tapes, and protected against installation damage by a skid wire helically wound over the cable. Three such cables to form one three-phase circuit are pulled together into a steel pipe which is then filled with degassed oil and maintained at a constant pressure of approximately 1.4 MPa. Since the three cables are close together in the pipe, mutual heating effects are more pronounced than with self-contained cables, and consequently a larger conductor for the same current-carrying capacity is required.

Right-of-Way Requirements

For cable circuits designed to operate at voltages up to and including 230 kV, the right-of-way requirement depends on the proposed location as follows:

1. *City streets*: Where a circuit(s) is to be installed in urban areas and will essentially be located within road allowances, sufficient working space for its installation is provided by the road allowance itself. Only physical space is required to install a circuit between or adjacent to other underground utilities, plus sufficient clearance to enable repair work to be carried out on either the cable circuit itself or the utilities adjacent to it. A clear space of 3 m will usually suffice to enable a single underground cable circuit to be installed regardless of the type of cable being used. Where more than one circuit is required, the circuits are generally located on separate routes to reduce the probability of coincident outages, and also to optimize their efficiency by preventing mutual heating occurring between them.

2. *Private right-of-way*: The right-of-way required to accommodate a single-circuit, high-voltage cable circuit on a private right-of-way is dependent on the necessary working space for its installation and maintenance. In general, for single circuits utilizing one conductor per phase, a right-of-way width of 4.5 m will suffice.

   For multiple circuits or for single circuits utilizing more than one conductor per phase, additional right-of-way width is required to provide for thermal independence of the cir-

cuits and varies according to the design of the circuits and the manner in which it is intended they be operated. Such right-of-way widths would be determined individually for specific cases. As an example: A two-circuit, 230 kV, high-pressure, pipe-type installation equivalent in current-carrying capability to a two-circuit, 230 kV, overhead line with a single 1843 kcmil copper conductor per phase would require a right-of-way width of approximately 15 m. A two-circuit, 500 kV, low-pressure, oil-filled cable installation to be equivalent to a two-circuit, 500 kV, overhead line with a four-conductor bundle of 585 kcmil conductors per phase would require three, 3800 kcmil conductors per phase and a right-of-way width of 30 m.

Construction Methods

Self-contained, low-pressure, oil-filled cables directly buried: The general method of installing a directly buried, oil-filled cable circuit involves opening a trench approximately 1.2 m wide by 1.2 m deep along the proposed route between predetermined jointing positions which are usually spaced aproximately 300 m apart. Depending on the location of the trench and the soil characteristics, it may be necessary to either partly or completely shore the sidewalls of the trench to prevent their collapse. The trench itself is generally excavated by a backhoe and if the route is along city streets, the pavement is first cut with a suitable saw along the outside edges of the proposed trench. Excavated material is either trucked away to a suitable dump or if all or part of it is intended for reuse, it is transported to a temporary storage site (if it cannot be stored along the trench).

The trench is carefully cleared of all debris, and concrete sidewalls approximately 0.3 m high are constructed, if they are deemed necessary. A cushion of crushed stone screening is then installed at the bottom of the trench and compacted by tamping. Cable rollers are then positioned along the bottom of the cable trench and the three cables installed one at a time. To install a cable, a winch truck is set up at one end of the trench and a reel containing the cable at the other. The steel winch cable is drawn along the trench over the cable rollers and fastened to a pulling eye at the end of the cable to be pulled into the trench. In some instances, the cable is pulled in by attaching it at regular intervals to a messenger cable, rather than pulling directly on the pulling eye at the cable end. After the cable has been pulled into the trench, it is removed from the rollers and positioned into the trench, and the pulling operation is then repeated for the second and third cables. When all cables have been installed and tested for soundness, they are then covered with crushed stone screenings which are compacted by tamping, and a precast or poured concrete cover is installed overall.

During installation of the cables in the first section of trench, a second section is being opened and the jointing position prepared for cable splicing.

By the time cables have been installed in the second section, a third section has been opened, and the backfilling of the first section has commenced. It is therefore apparent that when installing directly buried cables, there is usually a trench length of approximately 900 m over which activity of some kind is taking place at any given time for a period of up to six weeks. Since such an operation is very disruptive in built-up areas, directly buried cable circuits are not considered particularly suitable for urban installation.

Self-contained, low-pressure, oil-filled cables installated in ducts: This type of cable system uses the same cable as used for directly buried installations. Construction methods differ in that concrete enclosed ducts are constructed in the cable trench, and permanent concrete manholes are constructed at the jointing positions. When constructing the duct bank, it is not necessary to have such long sections of trench open at any given time. The equipment used for construction of the duct bank and installation of the cables is essentially the same as that used for directly buried cable, but there is not a requirement for a full length of trench between jointing positions to be open. The current-carrying capability of cables installed in ducts is somewhat less than that of the same cables directly buried due to the difference in heat transfer capability of the air surrounding the cables in the duct, and the duct itself, relative to the crushed stone screenings which surround the directly buried cables.

High-pressure, pipe-type cable: This type of cable system involves installation of a steel pipe approximately 1 m below grade into which three insulated conductors are drawn. The length of conductor drawn into a section of pipe may be several hundred metres and is dependent on the number and severity of the vertical and horizontal bends.

Construction procedures involve proving out the feasibility of the proposed grade of the pipe between proposed manhole locations by digging testholes at strategic positions, construction of reinforced concrete manholes at jointing locations, installation of the pipe, installation of the cable, construction of an oil pumping plant at one end of the cable circuit, jointing the cable, and filling the pipe with degassed oil.

The construction of a manhole necessitates excavation and shoring of a hole of sufficient size to accomodate the manhole. The length, width and depth of a manhole for a single circuit of pipe-type cable is approximately 5.8 m by 2.5 m by 3.7 m. After excavation, the manhole is formed, reinforcing steel positioned and concrete poured.

Pipe installation requires a trench approximately 1 m wide to be excavated to a depth of approximately 1.2 m.. Excavated material is removed from the site unless it can be stored along the trench and reused. A bed of crushed stone screening is then placed in the trench and compacted into a layer approximately 150 mm thick. Coated steel pipe, generally 150 mm or 200 mm in diameter (depending on the conductor size and voltage level of the cable being installed) and in lengths up to 12 m, is then positioned in the trench on suitable supports, and the pipe lengths are welded together to form a continuous pipe. After welding, the supports are removed and the pipe centered on the bed of crushed stone screenings. The pipe is then covered to a depth of approximately 150 mm with crushed stone screenings. This material may, in some instances, be used to completely fill the trench, particularly if it is located in a roadway. Reinstatement of the trench at ground level to the condition which existed prior to excavation is then carried out.

After the pipe is installed and manholes constructed, cable installation takes place.

Three cables yoked together are pulled into each pipe section between manholes by a truck-mounted winch. The cable splices are then made in the manholes.

A prefabricated enclosed pumping plant located at one end of the cable installation, either within a transformer station or on property acquired for it, is used to fill the pipe with oil and to maintain a constant oil pressure of approximately 1.38 MPa.

Construction equipment associated with pipe-type cable installations consists of trucks, backhoes, concrete trucks, pipe benders, generators, winches and other construction equipment normally associated with the construction industry.

Operating and Maintenance Procedures

Self-contained, oil-filled, directly buried cable: Once this type of cable is installed there is very little of it which is visible or readily accessible. Operating and maintenance procedures are generally associated with checking the oil reservoir pressure gauges and oil piping at the cable terminations, and inspecting cable joints in those cases where they are contained in permanent manholes. It is also customary to periodically patrol the cable route so that any new excavation work which might endanger the cable circuit can be watched closely and contractors made aware of the cable's precise location. In the event of a cable failure, the location of the fault is determined electrically, if necessary, and the cable is excavated and repaired. This is usually a very time consuming operation and may take several weeks to complete.

Self-contained, oil-filled cable-duct and manhole installation: As with directly buried cables, routine operating and mainte-

nance procedures involve the checking of components at the cable terminations and in the manholes. In the event of a cable fault, it may be possible to withdraw the faulted cable section, provided the duct has not been severely damaged by the fault. If the cable could not be pulled out, it would be necessary to locate, excavate and repair the cable duct, and repair or replace the cable.

High-pressure, pipe-type cable: The heart of a high-pressure, pipe-type cable system is the pumping plant which supplies and maintains the pressure necessary to prevent the formation of voids in the cable insulation where ionization of gases would result in insulation failure. The pumping plant is equipped with dual pumps, and in the event of a pump failure, the duty of the failed pump is automatically assumed by the second pump. There is also an automatic alarm system which alerts the controlling station whenever there are problems associated with the pumping plant.

Maintenance procedures require the periodic checking of all automatic systems to ensure they are functioning properly, a route check to spot any potential hazards to the cable system, and an inspection of the jointing manholes.

4.2 Transformer Stations

4.2.1 General

A transformer station of the type covered by the class definition usually has four basic components, namely:

1. One or more high-voltage areas (115 kV and/or 230 kV).
2. One or more transformer areas.
3. One or more low-voltage areas (less than 50 kV).
4. A control, meter and relay area.

Figures 4-3 and 4-4 illustrate schematically the interrelationship of the first three basic components. The fourth component-the control, meter and relay area, serves as an overall monitor and control for equipment in the three other types of areas in the transformer station.

4.2.2 Basic Operation

The basic operation of the typical transformer station shown in Figure 4-3 is as follows:

Electrical energy enters the station from the power supply system through incoming transmission lines which terminate in the *high-voltage area*. Within this area are electrical conductors and electrical switches by which the incoming lines are connected to the transformers in the transformer area. In this simplest form of station, there could also be other conductors and switches which connect the lines together.

The electrical energy is directed to the *transformer area* where its voltage level is changed by transformers from 115 kV or

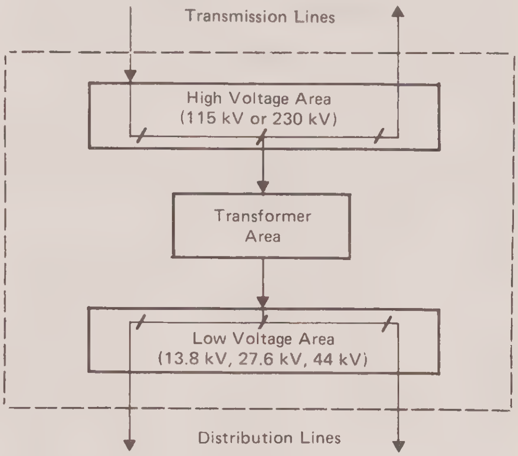


FIGURE 4-3
Transformer Station Components — Simple

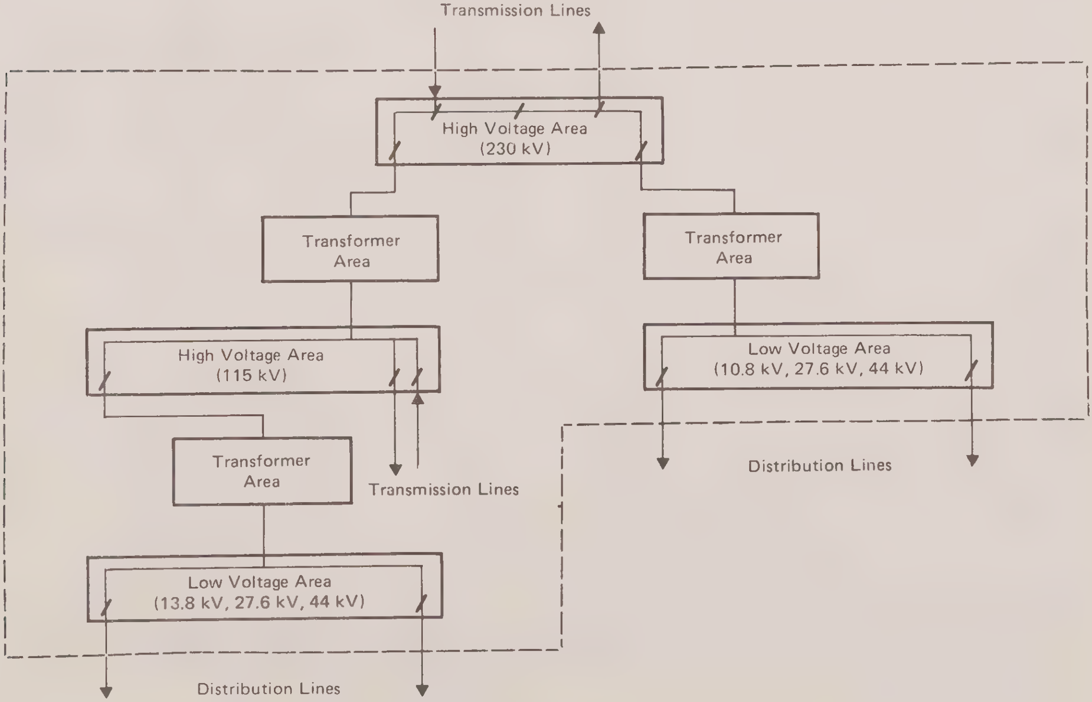


FIGURE 4-4
Transformer Station Components — Complex

230 kV to a lower voltage (below 50 kV). The electrical energy at the lower voltage is then directed through electrical conductors from the transformer area to the low-voltage area.

In the *low-voltage area*, the energy is directed through conductors to the low-voltage power lines which are connected to the associated subtransmission or distribution systems and then to the load.

The flow of energy through the station is controlled and monitored by instruments located in the *control, meter and relay area*. Certain of the control functions are initiated by operation action, others are initiated by automatic features designed to protect the station and/or line equipment in abnormal circumstances.

The operation of the complex station is essentially the same as the simple station, except that there is usually a flow of energy between the various lines connected to each high-voltage area and also between the high-voltage areas.

4.2.3 Alternative Designs

Transformer stations may be of either an *outdoor design*, where all or most of the major equipment is located in the open within a fenced-in area, or an *indoor design*, where the equipment is contained within one or more buildings.

With the outdoor design, the equipment in the high-voltage, transformer and low-voltage areas is usually supported on concrete foundations and/or structural steel. The control, meter and relay area is contained within a single-storey building. In some cases, one or more of the high-voltage or low-voltage areas may be contained in a separate building within the fenced area.

There are two basic types of outdoor stations generally in use, one which uses lower structures but requires more land and one in which the structures are higher but less land is required.

All components of an indoor design are contained within one or more multi-storey buildings which are designed to be as compatible with the surrounding environment as possible.

The area outside the station is landscaped to make it more esthetically compatible with its surroundings.

Lines connected to the station may be either overhead or underground.

4.2.4 Site Requirements

The total site requirement for a distributing station, including access roads, drainage and landscaping is approximately 91 m by 91 m or 0.8 ha. The area needed for a simple regional supply transformer station (Figure 4-3) typically varies from 0.2 ha for an indoor urban station to 4.5 ha for an outdoor station.

The area needed for the more complex combined regional supply and system interconnecting transformer station is about 22 ha.

The actual site size will vary depending on the availability of land, the type of station facilities installed, the number and orientation of the transmission lines, the character and use of adjacent properties, and the amount of land required around the station for landscpaing. The site size may also be affected by local bylaws governing the area.

Sufficient land is acquired to accommodate the maximum facilities foreseen for the particular station. The station is usually constructed in stages toward that maximum as the need develops.

A level, well-drained area with good soil bearing qualities is desirable for the station site. The station must be located such that heavy transformers can be transported to the site. Since the heavy transformers are needed to interconnect high-voltage switchyards in the more complex stations, it is usually necessary to locate these adjacent to a railway and/or build a spur line into the station.

4.2.5 Station Equipment

High-Voltage Area

The high-voltage area may contain circuit breakers (switches), load interrupting switches, disconnect switches and interconnecting bus work, as well as auxiliary equipment such as current and voltage transformers, lightning arresters and spark gaps.

The *circuit breakers* are used to direct the flow of energy by opening to interrupt or by closing to initiate the flow of electrical load current through particular conductors. Circuit breakers also have the capability to interrupt large currents which may be experienced under abnormal conditions.

The circuit breakers may be of three types:

1. A bulk-oil design with the electric current carrying and switching parts immersed in oil inside a grounded steel tank.
2. An air-blast design where the electrical parts are located in an air-filled pressure tank located on top of steel-supported porcelain insulators.
3. A gas circuit breaker where the current carrying and switching parts are located within a grounded metal cylinder containing insulating gas such as sulphur hexaflouride (SF_6).

The *load interrupting switches* are also used to interrupt and initiate load currents. However, they have only limited capability to interrupt abnormally high currents.

The *disconnect switches* which have virtually no current interrupting capability are used to isolate a piece of equipment from the system for maintenance purposes.

The load interrupting and disconnect switches may be of two types: an air-insulated unit with the electrical conductor and current-carrying parts mounted on steel-supported porcelain insulators to isolate it from the ground, or a gas-insulated (e.g., SF_6) unit in which the conductor and the current-carrying parts are located within a grounded aluminum or steel cylinder containing the insulating gas.

The *interconnecting bus work* connects together the major components in an area and connects one area to another area. The bus work may be of either rigid or flexible conductors, mounted or suspended from steel-supported porcelain insulators or rigid conductors supported within a sealed metal cylinder filled with gas (SF_6).

The *auxiliary equipment* (current and voltage transformers, surge arresters, spark gaps) are connected to the equipment or bus work and are used for the protection, control and monitoring of the station.

Outdoor stations may also contain a limited number of lightning protection towers to protect the station from lightning strikes.

Transformer Area

The transformer area contains one or more transformers which are used to change the voltage of the electrical power from one voltage level to another.

Each transformer consists basically of a steel tank containing electrical windings immersed in an oil bath. The conductors enter the tank through porcelain bushings on top of the tank. The oil, which acts as an electrical insulator and as a coolant, circulates through the transformer and cooling radiators mounted adjacent to the transformer. Oil pumps may be used to circulate the oil, and fans are used to force air through the radiators to increase the amount of cooling. Pits are constructed under all power transformers to contain possible oil spillage. The pits are filled with gravel to restrict oxygen to spilled oil to inhibit combustion in the event that the oil should be ignited.

All energized transformers produce a low-frequency sound. To ensure that the lowest ambient sound level at nearby residences will not be noticeably increased by the normal operation of the transformer, precautions are taken through the design of the transformers, their location within the station and the use of acoustical barriers.

The regional supply station usually starts with two power transformers in the first stage. As requirements develop, the station expands to a maximum of four or six units in the ultimate

development. Each pair of transformers is usually connected to its own low-voltage area.

Low-Voltage Area

The low-voltage area contains disconnect switches and circuit breakers interconnected by rigid conductors supported on porcelain insulators and auxiliary equipment such as voltage and current transformers. The equipment may be located outdoors and supported on structural steel and/or concrete foundations or contained within an enclosure. The devices are used to perform the same general function as described for the high-voltage area.

Control, Meter and Relay Area

The control, meter and relay area contains all the control, meter and relay instruments required to operate and control the complete station. These instruments are connected by electrical cables to the specified devices, e.g., circuit breakers, disconnect switches, current transformers located through the stations.

Washroom facilities are also located in this area. The sewage disposal system is designed to local and provincial regulations and usually consists either of an on-site disposal system or a direct connection to a municipal system. Water supply is either from an on-site well or from a municipal source.

If the station is of the outdoor design, the control, meter and relay equipment is contained within one or more single-storey buildings. For indoor stations, this equipment is contained in a room within one of the station buildings.

4.2.6 Construction

The first step in the construction of a station is to grade the site to provide a level area for installation of structures and buildings. Top soil is removed and stockpiled at the site for landscaping purposes. Surplus soil is disposed of in an approved landfill area.

After the grade is established, drainage and septic systems are installed and a fence is erected around the construction area. In the case of outdoor stations, this may be a chain link fence which will form part of the permanent fencing. In the case of indoor stations, temporary fencing is erected to municipal requirements.

Excavation for foundations and placing of concrete then proceeds. After completion of the foundations, the steel supporting structures and buildings are erected. Erection of the electrical equipment then begins. Most electrical power equipment is brought to the site by conventional road transport. The large power transformers are moved to the site using heavy load transportation equipment under the supervision of Ontario Hydro and local road authorities. In some instances, transformers can be moved directly to the site using rail facilities where these are available or have been provided. Landscaping is carried out during and after construction as site constraints and seasons permit.

4.2.7 Operation/Maintenance

In most cases, transformer stations of the type covered by Class EA are unattended and are operated remotely from a district control centre. A travelling operator makes periodic inspections and can be dispatched to the station in the case of an emergency. In stations where attendance is required, working facilities are provided within the control, meter and relay area.

Whenever preventative or emergency maintenance is required, a work crew is dispatched to the site.

4.3 Distributing Stations

4.3.1 General

Ontario Hydro maintains a network of subtransmission lines and distributing stations to provide electrical service to the rural distribution electricity systems. There are about 800 distributing stations province-wide, 70 of these stations are supplied at 115 kV. The rest are served at voltage levels less than 50 kV.

4.3.2 Basic Design

The new 115 kV distributing stations are of a low-profile open-type structural steel design (see Figure 2-3). The station switching structures and power transformers are contained in an area approximately 40 m by 35 m (less than 0.15 ha). The station is enclosed with a 2.4 m high chain link fence and situated in the middle of a parcel of land having a total area of 0.80 ha. The land between the station chain link fence and the property lines is used for grading, drainage, landscaping and sound attenuation purposes. The front, side and rear lot setbacks meet or exceed municipal requirements. A 3.5 m wide driveway is required to access the station for operating and maintenance purposes.

The distributing stations are unattended and do not require water or sewage connections to municipal systems.

Provisions are made in the station design to limit or contain transformer oil spills so that no adverse effects are suffered by the surrounding environment.

The electrical equipment contained in the distributing station is designed to prevent radio and TV interference.

The sound from the power transformers is within municipal standards and complies with the *Ontario Hydro Protocol for Community Noise Control*.

All municipal bylaws, regulations and codes are adhered to in the construction of the distributing stations. Land severences are approved through County Land Divisions or Municipal Committies of Adjustments. Building, land use and road service entrance permits are applied for and received before any field construction work is commenced.

4.4 Communication Towers

4.4.1 General

Ontario Hydro maintains an extensive communication network whose purpose is to protect and control the transmission system and the stations connected to it. The communication network allows continuous surveillance over major transmission facilities, and in the event of a malfunction on the system, it enables protective relay operation to automatically isolate the faulted system component. The communication network also gives Ontario Hydro operators continuous information on the status of major lines and stations under their control.

4.4.2 Basic Design

Communication towers are normally constructed of structural steel members and may be either self-supporting or guyed. Guyed towers may be used where land procurement or power station restrictions are not a problem. The height of the tower depends on the elevation of the site and the terrain that the radio signal must cross.

The only installation required in addition to the tower is a small and specially designed building for the associated equipment. Site improvement, including landscaping, is undertaken as necessary at each site. Setback and severence is in accordance with Ontario and municipal regulations. An access road to the radio site is also necessary if the tower is not located on a station site, but generally a parcel of land measuring 30 m by 30 m is sufficient. Most Ontario Hydro communication towers are located on or adjacent to transformer station sites.

Communication towers present no electrical hazard, nor do they interfere with radio or TV reception as the network operates on a different frequency band.

Appendix A
Ontario Hydro Regions and Areas

Ontario Hydro has divided the province into six administrative regions which are responsible for the day-to-day operation, maintenance, land and property management activities related to the distribution and bulk electricity systems.

Region	Regional Office
Central	North York
Eastern	Belleville
Georgian Bay	Barrie
Northeastern	North Bay
Northwestern	Thunder Bay
Western	London

Hydraulic generation, transmission and transformation facilities are operated and maintained by regional personnel to generate and transmit bulk power to distribution points. Distribution facilities are constructed, operated and maintained, and power is marketed and delivered to the various types of customers within each region. Customers vary from individual residences to heavy industrial users, each of which has its own specific requirements and demands for electricity. Properties are managed to derive maximum financial benefits for the corporation, and maintenance is carried out on rights-of-way and other properties to ensure reliability of service, to protect the environment and enhance corporate relations with the public and government. Regional personnel are also responsible for the enforcement of regulatory functions assigned to Ontario Hydro. Functional guidance for these activities is provided by Head Office divisions.

In order to make staff more responsive to the needs of the customer, each of the regions is subdivided into areas which vary in size and number according to the geography of the individual region. The office and service facilities serving the individual area are at a convenient location within the area. Each area is responsible for forestry, lines and customer relations activities associated with the distribution of electricity to the customers within its jurisdiction.

Appendix B
Load Forecasting Considerations and Methods

The Process of Growth

Between 1922 and 1977, primary energy demand grew at an average rate of 7.0 per cent per annum, with rates in individual years varying from a minimum of −13.9 per cent in 1931 to a maximum of 19.7 per cent in 1940. Both years witnessed events that can be regarded as extreme — namely the onset of the Great Depression and the outbreak of World War II. In the last decade, which has seen a dramatic increase in energy prices, growth has ranged from 7.6 per cent in 1972 and 1976 to −0.8 per cent during the 1982 recession.

During the period 1972-1982 average annual growth amounted to 3.2 per cent — less than half of its former rate, and between 1977 and 1982 it has averaged only 1.7 per cent.

Much of the growth in electricity demand in the last 20 years has come from space conditioning. As a result, demand has become much more sensitive to temperature, and relatively less sensitive to daylight. To a great degree, the advent of windowless space has made lighting demand independent of natural daylight.

Weather fluctuations and economic fluctuations are quite different in their impact on the system. While both are random and unpredictable, the duration of fluctuations due to weather is short; that of economic fluctuations is prolonged over a matter of years. In medium-range forecasting appropriate to Ontario Hydro's decision lead times, it is therefore much easier to deal with weather fluctuations than it is to cope with the business cycle. For one thing, it is relatively easy to define expected or normal weather conditions, and extremely difficult to do the same thing for economic conditions, because climate or average weather can safely be assumed to be stable.

The economic climate, or normal economic state is subject to change over time with inventions, wars, depressions and changes in population, lifestyles, incomes and prices. In other words, there are structural changes going on in society which profoundly affect the demand for electric energy over the long run—events such as sustained rates of immigration, birth rates, the urbanization of Ontario, the shift from single-family dwelling units to apartments, and the growth of tertiary industry. More recently there has been a growing concern with the environment and the quality of life. The impact of this concern on the demand for electric energy gives rise to considerable focus on growth in energy consumption in general and electric energy consumption in particular as evils to be avoided.

At the same time, the importance attached to the quality of the individual's personal indoor environment has led to a growth in air conditioning and electric heating. Insofar as cleaning up the atmosphere and the provincial waterways is concerned, industries and municipalities can comply by introducing electrically powered equipment for recycling and removing materials from their effluents.

Since October, 1973, there has been growing concern with not only the price but the availability of primary fuels, especially oil and gas and their effects on growth in incomes and employment. However, the severe world-wide recession of 1981-1982 has delayed these fears, perhaps temporarily.

Electricity differs from most other forms of energy in that it is a manufactured product which can be made from almost any other type of energy. Consequently, it is able to draw on more technical alternatives than any other energy source, and this may tend to make its price more stable over the longer run. However, electricity supply is a very capital-intensive industry, so that fixed costs tend to rise in the presence of unforeseen low demand. This in turn puts pressure on unit costs, thence prices and back to demand. The spiral works in both directions.

Generally, the demand for electric energy has grown more rapidly in its mature phase than other types of energy. Electricity has therefore acquired an increasing share of the energy market in Ontario with the passage of time. In a very general way one could think of the 7 per cent growth in demand in these terms; a 2.1 per cent increase due to increasing population and a 4.9 per cent *per capita* increase consisting of a normal increase in the order of 3 per cent with the balance representing a shift to electric energy from other types. The dramatic change since 1977 has been the drop in growth of *per capita* usage – reflecting increased real electricity prices and stagnant per capita real income. The prospects for the future seen from this perspective in time, calls for a moderation in the rate of population growth (depending on fertility rates, net migration to Ontario from other provinces and Canadian immigration policy). While subject to considerable uncertainty, the prospects for the shift seem to be further towards electricity, depending on relative prices and availability of other fuels, the availability of capital and the thrust of public environmental policy and conservation efforts. At the same time, the thrust of research and development in all of the energy industries has shifted from finding new uses towards developing equipment which minimizes energy use because of its high cost.

The effects of price and incomes on the growth of demand for electric energy are extremely difficult to assess. In the industrial sector, the technical coefficients (units of electrical energy input per unit of output) do not seem to be especially stable within an industry and, or course, they vary considerably between industries. The prospects are that this approach will prove even less rewarding in the future than in the past due to the pollution abatement rather than to production. The commercial sector, which is growing most rapidly, has undergone considerable change in its nature of use of electricity, and there is uncertainty as to the future pattern of use.

Because residential consumption is relatively homogeneous (in comparison with industrial and commercial), it lends itself, to a greater degree, to statistical analysis.

What has been observed is that residential consumption is very responsive to incomes. This shows up very clearly in the behaviour of municipal residential consumption since World War II. There has been a remarkable stability in the relationship: monthly energy consumption is approximately the amount that can be purchased with the earnings from three hours of work. During this period, appliance prices and rate structures have remained relatively stable, but incomes have risen substantially. With the increasing number of households with both husbands and wife working, income per residential customer has been well maintained.

Much more difficult to estimate is the response of consumption to price. Part of the difficulty stems from the residential block rate which makes average price depend on consumption. This makes it impossible to observe the effect of price on consumption directly. In general, it is not possible to observe anything more than a series of points in different price-quantity relationships. However, in cases where there have been abrupt changes in rate level, it may be possible to estimate what consumption would have been in the absence of the rate change, and hence to estimate the effect of price on consumption. From this, crude estimates of price elasticity can be made. Studies to date indicate that price elasticity is also a function of time.

A customer's consumption of electricity by use of the particular stock of appliances that he owns probably does not respond immediately to any change in the price of electricity. However, a customer may greatly increase his stock of appliances and his

use of electricity, if there is a significant reduction in the price of electricity.

In the case of a price increase, consumers probably have to suffer a loss in order to dispose of or forego the use of appliances. In some cases (e.g., rental water heaters) where competitive forces permit an easy substitution without the customer suffering a capital loss, the adjustment can be quite drastic and rapid. In other applications, such as electric heating, the consumer has less freedom of choice, but nevertheless the impact on new business can be significant. In the long run, the relevant price in each application is the price relevant to competitive services.

This is an important area in which ignorance of the process persists. With the prospect of increases in all energy prices, but with variable timing of the impacts on different fuels, the near-term (next decade) uncertainty is quite large. The long-term outlook for the relative price of electricity is that it may tend to become more attractive if only because of the larger number of technical options open in the process of its manufacture.

While government policy may have little impact on the magnitude of total growth in Ontario, it is expected that it may have a considerable impact on the geographical distribution of that growth. This will depend on the degree to which market forces are overcome or redirected by that government policy. While there is almost complete agreement with this premise, there is no such unanimity on any particular alternative to it, and consequently the details must evolve through the political process. This complicates the forecasting problem in that political forces must be taken into account. It is necessary to forecast the outcome of the process which may prove to be quite different from the intent. This may pose problems in forecasting and will require at least that some additional provision for uncertainty be made in these forecasts on this account.

The Forecasting Process – General

The process of growth described in the previous section consists of inferences drawn from observation and study of growth in the demand for electricity in Ontario and elsewhere over many years. The description is an effort to relate the growth process in a general way to the wider economy and the society in which it operates. Such a description has explanatory merits, but it often lacks the precise quantitative relationships which are required for it to have merit for prediction. For one thing, a forecasting approach based on explanatory social and economic variables requires not only a reliable forecast of those variables, but a means of translating them precisely into electrical demand in Ontario. Moreover, the planning and decision requirements call for the geographical distribution of electrical load in Ontario as well as the time path of system demands. For these reasons, the forecasting approach in Ontario consists essentially of forecasts of individual customers' peak and energy loads which are accumulated into totals which are then translated into peak and energy demands by introducing estimates of diversity and/or losses. In some cases it may be necessary for loads to be forecast for customers who may not now exist. Unallocated load is used for this purpose.

Unallocated load can also be used to reduce the forecast in circumstances where judgement assisted by the results of forecasting models indicates that total estimates for a class of customers are too high, or too low while it may not be possible to isolate which particular forecast are wrong. For example, the total forecast for a group of paper companies may be unreasonable, but in the absence of a detailed assessment of the competitive position of each company, it is not possible to modify individual forecasts.

With the increase of decision lead times, a need for longer range forecasts has arisen. For these forecasts, mathematical models are essential. They serve only to narrow the range of uncertainty by a small amount. There are too many uncertainties to be captured by the most sophisticated model and they multiply as the forecast horizon and decision lead times are extended.

The load forecasting system in Ontario Hydro for the short-to-medium term consists of mathematical models and the application of the detailed knowledge of individual customers which is available from Ontario Hydro personnel in the field, within utilities and areas, and from direct customers served by Ontario Hydro. The reasons for adopting this detailed approach over that of deduction from global, social and economic causes are twofold:

1. It appears to produce aggregate or system forecast of greater accuracy than any deductive mathematical model which has been applied to date.
2. It produces the needed geographical details of customer peak demands which is needed for planning purposes, while a model using explanatory social or economic variables would tend to yield annual energy, perhaps by end-use category, which would then require disaggregation into monthly energy by geographical unit and translation into peak load.

The fact that this approach produces short-to-medium range forecasts with smaller errors than other methods is not altogether surprising when one considers that it brings to bear more relevant information than is the case with even the largest econometric model. As the time horizon extends into the future, the available knowledge becomes less, and consequently greater emphasis tends to be placed on mathematical techniques.

A disadvantage of the system for explaining the forecast, but not in using it for planning purposes, is that changes in explanatory economic and social variables — such as birth and immigration rates, incomes, changing consumer preferences, etc., — are captured by the approach, but they are not isolated by it. For example, increased demand by virtue of concern for the environment may show up in the forecast as a new sewage plant in a municipality and some additional pumps in a paper mill, but this load may or may not be specifically identified by its cause. Similarly, declining birth rates will show up in altered plans for housing types and quantity, but once again the cause will not be identified — although it may be speculated on after considering trends in the aggregate forecast. Moreover, the classification system of customers' loads is primarily geographical and administrative rather than by end-use classification, except perhaps for direct industrial load. In any event, even if end-use classifications were available, they would most likely refer to energy on an annual basis, and it would be extremely difficult to convert such predictions to peak load on a monthly basis with the required geographical distribution.

Consequently, the forecasting process as it exists differs from the process of growth as it has been described. Nevertheless, some understanding of the process of growth provides a useful background against which to assess the results of the forecasting process in an attempt to answer the vital final question: Are the results reasonable?

No forecast carries with it any guarantee of accuracy, and the occasional forecast can be badly in error. In assessing the bad forecasts it is useful to have available for scrutiny a general statement on expectations at the time the forecast was made. A forecast is bad only if a better one could have been made with the information on hand at the time. Anyone can make a good forecast with the benefit of hindsight. Similarly, an assessment of the uncertainties associated with the forecast gives its users some appreciation of the risks that they run and often provides an insight into the cause of subsequent forecast error.

The Forecasting Process – Specific

The Load Forecasting Department at Ontario Hydro maintains a historical data bank in which the peak and energy loads of all wholesale customers for each month since 1962 (or since the customer first took power where this is a later time) are stored. These records are updated monthly and are used to prepare each year's load forecast report and to monitor the forecast.

Short-Range Forecast of Customer's Loads

The basic forecasting model is mathematical and consists of a time series extrapolation model. It is used to provide a base projection for the preparation of the regional forecasts of individual system customers' loads. The model assumes that:

1. Growth is exponential, i.e., that the percentage growth per time interval is constant, and hence that a graphical plot of load on a logarithmic scale against time on a linear scale gives a straight line.
2. There may be seasonal pattern which will continue into the future.
3. Past history is homogeneous, i.e., that discontinuities in past load growth due, for example, to changes in municipal boundaries, can be ignored.

The model generates two load projections:

1. A least-squares projection which gives equal weight to each piece of historical information regardless of its date of occurrence. The model includes a provision to adjust the starting point of the forecast to bring it into line with recent experience without altering the rate of growth.
2. An exponentially weighted projection based on double exponential smoothing of the data. This method assigns weight to the data which depend on the time of occurrrence, with the more recent data being given more weight than older data. The weights which are chosen by the program can be thought of as the fraction of information contained in a new data item.

Where these two projections are in close accord, the indications are that the forecast will be fairly reliable, provided no factors which may cause a discontinuity with the past are likely to occur.

In general, of the two, the exponentially weighted projection tends to be the preferred one, especially where the historical growth rate has been changing. Although the model rests on an exponential growth assumption, non-exponential growth rates are better dealt with by this projection, although it must be emphasized that the projection itself is exponential.

The two projections are prepared for each customer each year and sent out to the regional marketing managers together with a blank form on which the most likely forecast, i.e., that forecast which has an equal probability of being high or low, is to be entered. The basic projections are offered as a guide to regional personnel in preparing their forecast. They are designed to enable them to concentrate their efforts where their knowledge lies and, in effect, lead to a process of forecasting by exception. The exceptions consist of:

1. Customers whose history is not homogeneous, or growth is not exponential, which is indicated by a discrepancy between the least-squares and exponentially weighted projections.
2. Customers where future discontinuities are expected by virtue of special factors such as annexations or other abrupt changes in trend.
3. Most industrial customers which are generally subject to discontinuous growth and generally not subject to seasonal patterns, but are sensitive to economic conditions.

One advantage in forecasting by exception lies in the explanations that are provided for rejecting the basic model. These frequently bring to light assumptions that must inevitably be made in a forecast of this type. At the same time, regional personnel are relieved of the tedium of preparing routine forecasts for those customers where growth has been, and is expected to, continue at stable rates.

The Load Forecasting Unit scrutinizes all customer forecasts received from regional personnel and those made by the computer in order to check:

1. The starting point, i.e., the first year of the forecast.
2. The rate of growth. Note that in the most likely forecast, in contrast to the mathematical projections, a constant rate of growth is not needed.
3. Seasonal pattern.

To assist in this work, a series of overlays are prepared for the graphs originally produced by the computer. These overlays show the regional forecast both in original graph they show differences between the most likely forecast prepared by regional personnel and the computer projections. Later, by plotting actual data on the overlays as it becomes available, they are used in monitoring the forecast. This enables early diagnoses if a forecast for a particular customer has gone awry, and is also useful as background for the next forecast.

A comparatively recent forecasting methodology, developed by Professors Box and Jenkins is being used increasingly to prepare short-term projects of system weekly and monthly demands, and also for critical customers or regional loads.

Long-Range Forecast

As long-range forecasting tools for system total sales, two further models have been developed. These are:

1. The Economic and Demographic Energy Model (EDEM).
2. The Ministry of Energy End-Use Model.

EDEM is an integrated set of prediction modules which generate a long-term projection — first of population which provides projections of households and the labour force. The next module is a macroeconomic model which provides projections of total output, incomes, and investment. An input-output model distributes this output to type of industrial activity.

Results from the demographic, macroeconomic, and input-output modules provide the required input such as households, income, employment to the energy sector equations.

With additional input on energy prices, energy quantities and fuel shares are then determined in the model.

The end-use model takes a somewhat different approach which stresses the engineering aspects of utilization equipment in the form of coefficients such as kilowatt-hours per ton of steel. It is a powerful approach in sectors where technological change is rapid, and it identifies energy markets in great detail. The strength of the approach lies in its detailed information (e.g., kW·h/ton of steel). This strength is offset by a corresponding weakness in that the tons of steel is determined by the forecaster's judgement often on a subjective basis with only vague and initiative notions of responses to such behavioural stimuli as prices and incomes.

Moreover, there are a great number of such external assumptions to be made. One result is that much time and effort is required in the preparation of a forecast, so that turn around is slow. Another result is that these forecasts are not easily replicated, and the monitoring process is also slow and tedious.

Neither approach provides results with the required geographic and chronological detail. The space module is the province of Ontario and the time module is one year. A further limitation is that vital information on the reliability of forecasts in the form of their error probability distributions are generally only provided via the generation of alternative scenarios to which subjective probabilities may be attached. In this respect, the EDEM model may be used more readily to generate error distributions (for example, by the Monte Carlo technique).

The major source of information about the error distribution of the forecast is the record of previous forecasts in relation to the actual outcomes. This can be done at any level from the individual system customer load to total system demand. An important determinant of the error distribution is the forecast lead time.

Appendix C
Accommodating the Official Load Forecast for Individual Detailed Studies

Customer Forecast Dissection

When dissecting a customer forecast into components, it must be decided whether the individual components will have either the same growth rate or different growth rates. In either case, the growth rate of the sum of the components should be approximately the same as indicated in the load forecast report. The only exceptions to this rule would be:

1. Where new information, not available when the forecast was being prepared, is to be included in one or more of the component loads, and;
2. To study the sensitivity with respect to load growth of the timing of new facilities or of the choice of alternative new facilities, a higher or lower rate than in the forecast is used. Use of such a growth rate would normally be made in addition to and not in place of the official growth rate.

The choice between the same or different component growth rates in each particular case would depend firstly on the geographical homogeneity of the municipality or area. Is one section more developed or growing faster than another section? For example, the southwestern part of the Borough of Scarborough is nearly fully developed and is growing slowly, whereas the northern part is still undeveloped, but expected to grow very quickly in future. It also depends on the type of development going on in various parts of the customer area. One part may be devoted to single-family or low-rise apartment residential development, another to high-rise commercial and/or residential development, and still another to industrial development. Each of these parts would have its own particular growth rate due to population increases, *per capita* increases in consumption, and shifts from one form of energy to another.

The decision as to whether or not component load growths will be considered the same or different can be made by the system planner alone, but in most cases he will seek the advice of regional, area or municipal utility staff. If it is decided to use different rates for each component, the choice of the rates would be made in one or more of the following ways:

1. By the planner using available historical data.

   For example, the large utility (or area) may be supplied by several transformer stations or distributing stations. Taking care that all past load transfers between stations are included, historical growth rates on the stations can be taken as the expected growth rate for each part of the utility (or area). This method would require only a minimum of contact with regional and/or utility (or area) personnel.

2. By consultation between the planner and the utility (or area) staff.

   In this case, the component projects would probably be based on historical data as above, but modified by the intimate knowledge of the local staff to reflect new developments.

3. By the municipal utility staff.

   In this case, the component forecasts, particularly in the early years, may be based entirely on known building starts, issued building permits, approved subdivision plans and firm enquiries about electrical supplies.

Combining Customer Forecasts

If more than one system customer, or parts of more than one system customer, are supplied from existing facilities at the anticipated system weak point, or will be supplied from the proposed new remedial facilities, these customer loads and customer load components must be combined for use in the detailed study. A decision must be made as to whether or not these loads might peak at the same time. If they are similar types of load and are geographically close to one another, then they are likely to peak together and it would be adequate simply to add the forecasts together. If they are different types of load, they could peak at different times of the day, i.e., downtown commercial load might peak at 11:30 in the morning, while residential load supplied from the same station may peak at 5:30 in the evening. In combining these loads, a diversity factor (a multiplier less than unity) would have to be used. If the customers are geographically (and electrically) some distance apart, the supply facility will have to provide for some line losses as well as supply the customer loads. In combining these loads, a loss factor (a multiplier more than unit) would have to be used. Establishment of these diversity and loss factors is the responsibility of the planner in consultation with utility or area personnel. They are usually based on historical data.

Extending Forecasts

While the six-year period of the official customer forecasts does not include the lead time required between the authorizing date of any new project, which would be covered by this Class Environmental Assessment Document, and its completion date, it is not sufficiently long, in most cases, for a complete evaluation of that option relative to the possible alternatives. The initial stage of each alternative option which might be utilized to correct an *inadequacy* in the system will likely have a different period of effectiveness ranging from one year to a possible 10 years or more. A complete study would therefore have to consider the next stage and possibly even the third stage for each option, up to that point into the future when all options arrive at essentially the same facilities. To make this comparison, long-range forecasts, not necessarily by customers but certainly by supply station or by supply area, are required. The usual practice is for the planner to project the eight-year study load forecast as follows:

1. Indefinitely into the future at the six-year growth rate, if it is constant over the six years, or at the growth rate forecast between the seventh and eighth years if it is not. This method would be used if the growth rate is based primarily on *per capita* load increases with little of the population increase or energy shift components.
2. At the six-year growth rate for one to four further years, and then at a reduced rate signifying a decrease in either the population increase and energy shift factors or both. Further reductions in the growth rate might be projected at intervals, particularly if the six-year growth rate is very high, i.e., if the load area is presently developing rapidly.
3. At a specific growth rate (or rates) determined in consultation with utility, region, or area personnel to include particular conditions, e.g., to match the Ministry of Housing's long-range forecast for the development of a new town such as the North Pickering Community.

In common with a large number of engineering organizations Ontario Hydro's method for making economic comparisons between alternative schemes is based on discounted cash flow. Using this method, later capital expenditures are less accurate the longer the forecasting period, but because of the basis of the economic study, this increasing inaccuracy is not reflected in the results of the economic comparisons made using these forecasts.

Changing to Apparent Power

The ratio between the real power and the apparent power supplied to a load (termed the power factor) is, except for pure resistive loads, less than 1.0 and usually greater than 0.9 (industrial customers with a power factor less than 0.9 are required to pay penalty). Historical data are used in estimating what the future power factor of a particular customer, station or geographical area is likely to be.

Appendix D
Inventory of Existing Supply Facilities Checklist

Generation

All existing and planned generation which may be feeding into the high-voltage lines or stations in the area of concern should be included in the inventory. The inventory will include the following steps:

1. Identify the location, type and size of each plant.
2. Determine the number of units and the normal and emergency ratings and capabilities of each.
3. Obtain historical data relevant in forecasting the future performance of the generation facilities, including data concerning forced outages due to equipment failure or human error, and scheduled outages for maintenance.
4. Identify possible conflicting requirements in operating the generation facilities from overall system considerations and from purely local considerations.

Transmission Lines

All existing and planned transmission lines located within or in the vicinity of the area of concern may be of importance in studies for the area and will be included in the inventory using the following steps:

1. Identify line route, width of right-of-way and line length.
2. Identify types of structures, number of circuits, number and type of insulators per string and type of line hardware.
3. Determine the voltage rating of the line.
4. Determine the electric current capability (ampacity) of phase conductors. (Refer to Transmission Design Methods, No. 9, November, 1972.)
5. Obtain records concerning line performance, including forced outages due to weather, equipment failures and human error, and scheduled outages for maintenance. (Refer to the Power System Operations Division Outage Reporting System.)
6. Obtain other pertinent data from design engineers and operating and maintenance staff.

Terminal Stations and Step-Down Transformer Stations

All existing and planned stations located within or in the vicinity of the area of concern may be of importance in studies for the area and will be included in the inventory using the following steps:

1. Identify location and property limits.
2. Obtain station drawings. (These usually include station bus, line and major equipment connections; transformer and switchgear nameplate data; connections to metering, control and protection; and other auxiliary equipment.)
3. Identify the location, connections, capabilities and ratings of all special station equipment such as synchronous condensers, combustion turbines and generators, reactors and capacitors.
4. Obtain records concerning overall station performance and performance of station components, including forced outages due to weather, equipment failures and human error, and scheduled outages for maintenance.
5. Obtain other pertinent data from design engineers and operating and maintenance staff.

Subtransmission

All existing and planned subtransmission lines and distributing stations located within or in the vicinity of the area of concern may be of importance in supply studies for the area and will be included in the inventory by following these steps:

For lines:

1. Identify line route, width of right-of-way and line length.
2. Identify types of structures; number of circuits, number, type and composition of phase and ground wires; type of insulators and line hardware.
3. Determine the voltage rating of the line.
4. Determine the electric current capability (ampacity) of phase conductors. (Refer to Transmission Design Methods, No. 9, November, 1972.)
5. Obtain records concerning line performance, including forced outages due to weather, equipment failures and human error, and scheduled outages for maintenance. (Refer to the Power System Operations Division Outage Reporting System.)
6. Obtain other pertinent data from design engineers and operating and maintenance staff.

For stations:

1. Identify location and property limits.
2. Obtain station drawings. (These usually include station bus, line and major equipment connections; transformer and switchgear nameplate data; connections to metering, control and protection; and other auxiliary equipment.)
3. Identify the location, connections, capabilities and ratings of all special station equipment such as mobile or spare transformers, combustion turbines and generators and capacitors.
4. Obtain records concerning overall station performance and performance of station components, including forced outages due to weather, equipment failures and human error, and scheduled outages for maintenance.
5. Obtain other pertinent data from design engineers and operating and maintenance staff.

Appendix E
Power System Stability

Power System Stability

One of the important considerations in the design and operation of a power system is the stability of the system. The term power system stability, as ordinarily used, is applicable only to three-phase ac power systems having synchronous machines which encompass practically all large present-day power systems. It denotes the ability of the synchronous machines to remain *in synchronism* through normal and abnormal system conditions.

A brief discussion of the characteristics of a synchronous generator is useful in the understanding of the various aspects of power system stability. Figure E-1 shows the basic elements of a generating unit consisting of a synchronous generator, a turbine and the associated controls. The generator has two sets of windings, one set wound on the stator and the other on the rotor. The rotor winding is excited by direct current and is referred to as the field winding. The turbine drives the rotor and the magnetic field produced by the rotor winding induces alternating currents in the stator windings which are supplied to the load. The frequency of the ac in the stator depends on the speed of the rotor, i.e., the electric frequency is synchronized with the mechanical speed and this is the reason for the designation of synchronous machine. The field winding is supplied from an exciter which may be a dc generator or a controlled rectifier. The voltage of the exciter is varied by an automatic voltage regulator to control the terminal voltage of the synchronous generator. The exciter and the automatic voltage regulator are part of a control system which is called the excitation system.

When two or more generators are connected in a power system they must operate in synchronism, i.e., at precisely the same average speed. The two generators are in some ways analagous to two cars speeding around a circular track and joined by a strong rubber band. If the two cars run side by side, the rubber band will remain intact. If one car temporarily speeds up with respect to the other car, the rubber band will stretch and tend to slow down the faster car and speed up the slower car. If the pull on the rubber band exceeds its strength it will break and the one car will pull away from the other car thereby breaking synchronism. The pull on the rubber band is related to by the angular displacement between the two cars.

In the case of two synchronous generators connected in a power system, the power transferred from one generator to the other is a function of rotor angle, and has the characteristics shown in Figure E-2. Under normal operating conditions, the rotor angle is such that no power is transferred from one generator to the other. As the rotor angle increases the power transferred increases until it reaches a maximum value. The magnitude of this maximum power depends on the impedance of the system connecting the generators, being greatest when the impedance is lowest.

Normally, the mechanical output of the turbine closely matches the electrical output of the generator and the speed of the generator remains constant. If a fault occurs close to one of the generators, its voltage drops and its electrical power output is drastically reduced. The mechanical output of the turbine then exceeds the electrical output of the generator and the excess mechanical power causes the rotor to speed up and the rotor angle to increase. When the fault is removed, the greater rotor angle causes power to be transferred from one generator to the other, and if sufficient energy can be transmitted between generators, the generators will remain in synchronism. A strong transmission system between the two generators is analogous to a strong rubber band between the two cars.

If the initial disturbance is too severe, or if the transmission cannot carry enough energy to ensure synchronism, then the generator will pull out of step. When the generator pulls out of step, it must be quickly removed from the system or it will cause severe voltage disturbances, may cause other generators to pull out of step and may cause damage to the generator and other equipment.

For convenience in analysis and for gaining useful insight into the nature of the stability problem, it is usual to classify power system stability in terms of the following categories.

Transient Stability

Transient stability is concerned with the response of the system to a large disturbance such as a fault on the transmission system. Transient stability is normally concerned with the behaviour of the system up to about 2 s following the disturbance.

The nature of the behaviour of a synchronous machine for stable and unstable situations is illustrated in Figure E-3. The figure shows the rotor angle following a sudden disturbance for a stable situation and for two unstable situations. In the stable case, the rotor angle increases to a maximum, then decreases and oscillates with decreasing amplitude until it reaches a steady state. In the unstable cases, the rotor angle continues to increase until synchronism is lost or it continues to oscillate with increasing amplitude until it loses synchronism in one of the subsequent swings.

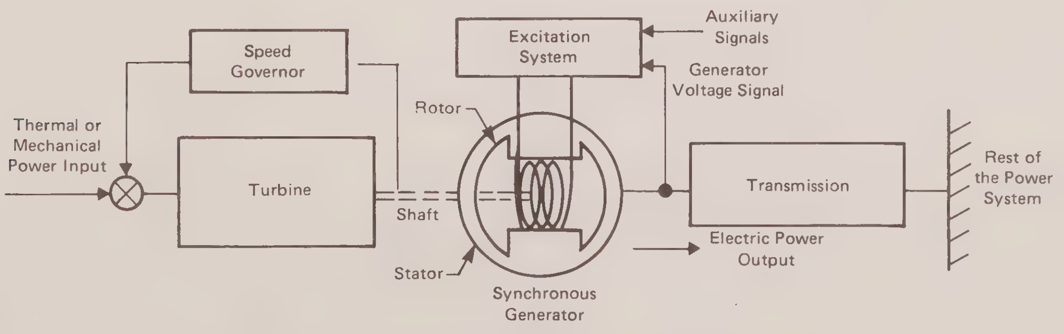


FIGURE E-1
A Turbine-Generator Unit and its Controls

Small Disturbance Stability

Small disturbance stability is concerned with the response of the system to small disturbances which continually occur in the operation of a system. This response is very dependent on the characteristics of the excitation system used. The use of supplementary stabilizing signals in the excitation system provides a means of improving small disturbance stability. In fact, for most system arrangements it is possible to design and install an excitation system which will completely eliminate small disturbance stability problems.

Ontario Hydro uses an excitation control scheme with the stabilizing signal derived from turbine-generator shaft speed. Initially, the scheme was developed for hydraulic units and was later applied to thermal units also. The possibility of exciting torsional oscillations of the turbine generator shaft system had to be eliminated before the scheme could be applied to thermal units. This type of excitation control is now a standard feature for all new generating units.

Stability Limit

The power system stability problem is one of keeping the interconnected synchronous machines in synchronism. Since it is the network that provides for power flow between generators and loads and between different generators, the strength of the transmission network is the primary factor in influencing stability. However, the characteristics of the generating units and the associated controls also have significant effects on stability. For any given system, there is a maximum amount of power that can be transferred from one part of the system to another due to stability considerations. The critical value of power above which the system is unstable and below which it is stable for specified disturbances is called the stability limit.

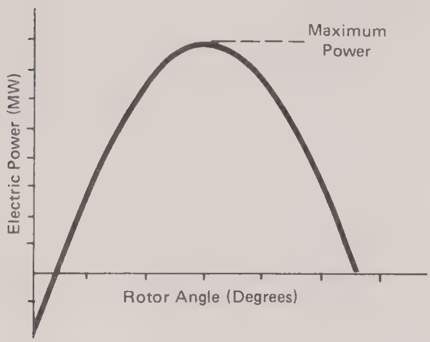


FIGURE E-2
Power-Angle Relationship of a Synchronous Generator

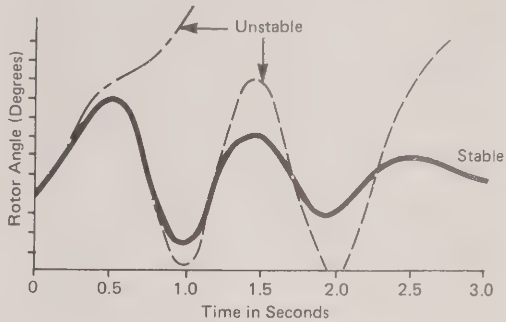


FIGURE E-3
Nature and Behaviour of a Synchronous Machine for Stable and Unstable Situations

Appendix F
Computer Programs Used in System Analysis

Load Flow Program

Load flow programs are the most frequently used programs for system studies. The basic input comprises the electrical connections, generator, transformer and transmission circuit electrical characteristics; the power and reactive power to be supplied at each load point; and the generator power output and voltage.

The load flow can show the expected power and reactive power flow in hundreds of circuits and transformers and the voltage at hundreds of system supply points.

The largest program used by Ontario Hydro can solve a power system with up to 4000 station buses and 10,000 interconnecting circuits. Computer running time on a large high-speed computer for a large power system is about 5 to 10 min. Other programs for smaller systems are also available.

Transient Stability Program

For one load flow it may be necessary to perform many transient stability runs for different types of faults and different fault locations.

A transient stability program is considerably more complex than a load flow program because it must solve the dynamic equations associated with acceleration or deceleration of the generator-turbine rotating masses and with the excitation and governor control systems. This is in addition to carrying out a series of load flow analyses separated by discrete time intervals of say, 0.05 s, to determine the power flows and voltages existing in the network as the generator angles swing relative to each other. Transient stability analyses normally examine the first 3 s of system time following a disturbance, requiring some 60 load flow analyses. The computer running time is about 30 to 45 min.

The program provides the time variation of many quantities such as:

- Generator rotor angles
- Generator power
- Bus voltages
- Circuit power flows
- Excitation system voltage
- Turbine power

The program can also monitor power swings on specified circuits, comparing these with the protective relaying characteristics of the circuit. If a power swing enters the protective zone of the line relays, the program alarms the relay operation in the output data.

Small Disturbance Dynamic Stability Program

This is a program used to determine the stability of a multimachine power system for small disturbances. The program is used for the following purposes:

1. To determine the dynamic stability limit of power systems under different operating conditions.
2. To evaluate the effect of machine, transmission system and excitation system parameters on small disturbance stability.

Short-Circuit Program

Programs are available to calculate short-circuit currents and voltages as required for the design of protective and other equipment.

Switching Surge Program

Ontario Hydro's switching surge program represents up to 750 buses and up to 900 elements. Between 55 and 100 generating sources may also be represented depending on whether the system is being studied on a three-phase or single-phase basis.

One version of the program is capable of representing the closing of a three-phase circuit breaker (or switch) with various distributions of closing time and sequence in each of the three-phases relative to a *target* or ideal closing sequence. The programs will automatically examine 100 cases of various closing times and will provide probability curves of the highest voltages expected. It will repeat the *worst* or highest case with complete results, including automatic plots of the voltage time curves.

Transformer Aging Program

Based on known test data and insulation aging characteristics of transformers, the hottest temperature spots in the transformer windings can be determined for various assumed overloads. The resultant *aging* of the insulation can also be calculated with reasonable accuracy. The temperature rises vary with the amount of overload and the *history* of loading prior to the overload. Such knowledge of overload capacity enables rational decisions to be made about the timing of transformer replacements and new transformer installations.

Appendix G
Environmental Factors

GLOSSARY OF ENVIRONMENTAL TERMS:

Environmental Situation – any characteristic of the environment which is expected to be affected by transmission facilities/activities and is described by using specific data collected for that purpose.

Environmental Objective Statement – a two-part statement consisting of:

1. A directive to "avoid" a particular type of environmental situation(s) characterized by specific descriptive data contained within the inventory; and
2. An appended "because" clause outlining the reasons why such a situation(s) should be avoided in terms of the changes which might be expected if transmission facilities/activities were to be located there and the perceived significance of those changes.

Environmental Factor – a class/category of concerns represented by a group of related constraint objective statements (e.g., Agriculture Production, Recreation, etc.).

The following is a description of the environmental factors frequently assessed by Ontario Hydro when carrying out environmental assessments. Accompanying each of the factors are examples of typical environmental situations and data sources.

HUMAN SETTLEMENT

Description:

This factor considers the predominantly man-modified environment, characterized by an extensive use, a high degree of human activity and extensive improvements.

Examples of Typical Environmental Situations:

1. Cities, town, villages.
2. Small centres of regional significance.
3. Seasonal development.
4. Institutions.
5. Military facilities.
6. Industrial development.
7. Commmercial tourist facilities
8. Airports and airstrips.
9. Communication towers.

Typical Data Sources:

1. Existing Land Use
   (a) Topographical maps.
   (b) Aerial photography.
   (c) Ministries of:
      - Transportation and Communications.
      - The Environment.
      - Agriculture and Food.
      - Natural Resources.
      - Tourism and Recreation.
      - Colleges and Universities.
   (d) Conservation Authorities.
   (e) Transport Canada.
   (f) Parks Canada.
   (g) Field Inspection.
   (h) Air Photo Interpretation.
   (i) Upper and Lower Tier Municipalities.
   (j) Zoning By-laws, Official Plans.
2. Proposed Land Use:
   (a) Ministries of:
      - Municipal Affairs and Housing.
      - Natural Resources.
      - Transportation and Communications.
      - Tourism and Recreation.
   (b) Conservation Authorities.
   (c) Parks Canada.
   (d) Local Planning Departments and Boards.
   (e) Upper and Lower Tier Municipalities.

AGRICULTURE

Description:

This factor considers agricultural production and associated practices through analysis of the potential of the land to produce agricultural products along with the present use and productivity of that land.

Examples of Typical Environmental Situations:

1. Areas of significant fruit, vegetable and tobacco production.
2. Prime agricultural soils with a high concentration of common field crops.
3. Prime agricultural soils with a moderate concentration of common field crops.
4. Prime agricultural soils with a low concentration of common field crops.
5. Restricted agriculture characterized by irregular field size and poor quality soils.

Typical Data Sources:

1. Soil Capability for Agriculture, Canada Land Inventory (CLI), Information Canada.
2. Hoffman Assessment of Soil Productivity for Agriculture — A.R.D.A.
3. Census of Agriculture, Statistics Canada.
4. Ministries of:
   (a) Correctional Services.
   (b) Agriculture and Food.
   (c) Health.
   (d) Colleges and Universities.
   (e) Transportation and Communication.
   (f) Natural Resources.
5. Topographical Maps.
6. Air photo interpretation.
7. Field Inspection.

TIMBER PRODUCTION

Description:

This factor considers the resource use aspects of forest cover, both from the point of view of the use of existing forests and the capability to produce renewable forest resources.

Examples of Typical Environmental Situations:

1. Forestry land with the Ontario Land Inventory (OLI) Timber Use Capability of Classes 1, 2 and 3.
2. Forested land with the OLI Timber Use Capability of Clas-

ses 4 or 5, currently supporting mature or immature valuable species, e.g., hard maple.

3. Forested land with the OLI Timber Use Capability of Classes 4 or 5, currently supporting mature and immature species of less value, e.g., white ash.
4. Forested land with the OLI Timber Use Capability of Classes 4 or 5, currently supporting mature or immature species of poor value, e.g., aspen, unmerchantable species and cutover of burned lands.

Typical Data Sources:

1. Timber Use Capability; Ontario Land Inventory; Ministry of Natural Resources.
2. Forest Resource Inventory; Ministry of Natural Resources.
3. Air photo interpretation.
4. Topographic Maps.
5. Field Inspection.

MINERAL RESOURCES

Description:

This factor considers the mineral extraction industry through analysis of existing and planned extractive operations and potential reserves.

Examples of Typical Environmental Situations:

1. Existing and proposed surface and subsurface extractions of metallic/nonmetallic minerals and structural materials.
2. Potential aggregate from sand and gravel deposits within a critical distance of identified demand centres.
3. Oil and gas deposits.
4. Potential aggregate and potential structural materials from sources such as bedrock.

Typical Data Sources:

1. Ministry of Natural Resources,
   Mineral Resources Branch,
   Aggregate and Geological Inventories,
   Regional Geologists.
2. Ministry of Transportation and Communications.
3. Topographic maps.
4. Field inspection.
5. Air photo intrepretation.

RECREATION

Description:

This factor considers existing forms of recreation (i.e., parks, cottages, major waterways, etc.) along with extensive recreational activities (i.e., canoeing, hiking). Future recreational potential is also considered.

Examples of Typical Environmental Situations:

1. Federal and provincial parks, park reserves and candidate parks.
2. Sensitive recreational waterways.
3. Sensitive linear areas, e.g., canoe routes, hiking trails, scenic roads.
4. Conservation Authority lands.
5. Areas of cottage and resort developments.
6. Areas identified as recreational in the *Canada Land Inventory*.

Typical Data Sources:

1. Ministries of:
   (a) Natural Resources.
   (b) Transportation and Communications.
   (c) Tourism and Recreation.
2. Conservation Authorities.
3. Parks Canada.
4. Outdoor Recreation Capability — Canada Land Inventory.
5. Topographic maps.
6. Field inspection.
7. Air photo interpretation.

APPEARANCE OF THE LANDSCAPE

Description:

This factor considers the physical appearances of different landscapes and their suceptibility to change due to the imposition of transmission facilities.

Examples of Typical Environmental Situations:

1. Escarpments and mountains.
2. Crests.
3. Vistas.
4. Landscapes visually dominated by water.
5. Flat to gently rolling landscapes with little tree cover.
6. Remnant natural landscapes and natural river valleys.

Typical Data Sources:

1. Topographical maps.
2. Air photo interpretation.
3. Field interpretation.

TERRESTRIAL COMMUNITIES

Description:

This factor considers the material biophysical (plant and animal) aspects of land-based communities in terms of unique features and the relative stages of natural ecosystem development.

Examples of Typical Environmental Situations:

1. Sensitive biological areas.
2. Undisturbed terrestrial communities characterized by mature climax forests.
3. Terrestrial communities characterized by immature climax forests.
4. Terrestrial communities characterized by mature nonclimax forests.

Typical Data Sources:

1. Ministry of Natural Resources.
   (a) Surveys and Mapping Branch.
   (b) Regional and District Offices.
   (c) Parks and Recreational Areas Branch.
   (d) Ontario Geological Survey.
2. Canada Department of Agriculture.
3. Air photo interpretation.
4. Topographic maps.
5. Field inspection.

AQUATIC COMMUNITIES

Description:

This factor considers the water system component of the natural environment in terms of water quantity and water quality.

Examples of Typical Environmental Situations:

1. Wetlands (swamps, bogs and marshes).
2. Cold-water fish communities (lakes and streams), e.g., trout.
3. Cool-water fish communities (lakes and streams), e.g., walleye.
4. Warm-water fish communities (lakes and streams), e.g., bass.

Typical Data Sources:

1. Ministry of Natural Resources:
   (a) Fisheries Branch.
   (b) Regional and District Offices.
   (c) Surveys and Mapping Branch.

(d) Ontario Geological Survey.
   (e) Wildlife Branch.
2. Agriculture Canada.
3. Air photo interpretation.
4. Field inspection.

WILDLIFE RESOURCES

Description:

This factor considers wildlife as a resource through analysis of natural habitats presently supporting, or capable of supporting, populations of wildlife game species.

Examples of Typical Environmental Situations:

1. Waterfowl nesting and staging areas.
2. Wildlife management areas.
3. Classical Wildlife Areas according to Ontario Land Inventory.
4. Deer yards.
5. Moose yards.
6. Endangered species habitat.

Typical Data Sources:

1. Ministry of Natural Resources:
   (a) Parks and Recreational Areas Branch.
   (b) Surveys and Mapping Branch.
   (c) Wildlife Branch.
   (d) Regional and District Offices.
2. Judd, W.W., et. al. (1974), A Naturalist's Guide to Ontario, University of Toronto Press.
3. Air photo interpretation.
4. Field inspection.

HERITAGE RESOURCES

Description:

This factor considers the cultural landscape, including the built-up environment with historical significance and archaeological resources.

Examples of Typical Environmental Situations:

1. Designated historical sites, e.g., buildings and plaques.
2. Buildings of historical architecture, e.g., churches, houses, mills.
3. Settlement patterns, e.g., survey fabric, fence rows, etc.
4. Known archaeological sites.
5. Areas of archaeological potential.

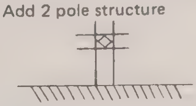
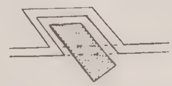
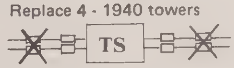
Typical Data Sources:

1. Ministry of Citizenship and Culture.
   (a) Regional Archeologists.
   (b) Historical Planning Board.
2. Upper and Lower Tier Municipalities.
3. Historical county atlases of Ontario.
4. Archaeological Consultants.
5. Survey plans of Ontario Townships.
6. Local historical associations.
7. Local published and unpublished histories.
8. Air photo interpretation.
9. Field inspection.

Appendix H
Examples of Projects Potentially Eligible for the Screening Process

The examples shown in Table H-1 illustrate the type of projects undertaken under the Class environmental assessment process prior to January 1, 1984. Projects of this type may now proceed without requiring a detailed study, assuming they qualify, as determined by the Screening Process described in Section 3.3.4.

TABLE H-1
Example of Projects Potentially Eligible for the Screening Process

Project	Description	Facilities
115 kV Interspace Structure Allanburg TS Crowland TS	Clearance between towers 6 and 7 not adequate for summer peak load	Add 2 pole structure 
Newburg Jct	Installation of a 230 kV air break switch ● Total outage could result to Brantford TS for 12 hours if line section from Newport Jct to Buchanan TS is not isolated	● Tapping existing structure ● Add -2 -3 pole structures and switch structure on Hydro owned right-of-way
Relocation of 115 kV circuit for the Woodruffe Demonstration project	CMHC required 1.6 km of line to be relocated in order to better utilize available land	
Toronto Leslie TS — tower replacement	Replace/relocated existing suspension towers with new, sturdier semi-anchor towers	Replace 4 - 1940 towers 
Chats Falls GS x Dobbin TS	3 lines require upgrading since design did not include for 6% growth and resulting temperature increases	15 tower extensions 6 - 9 m 8 new tower footings
Iroquois Falls GS x Monteith SS x Kirkland Lake TS	Upgrade 115 kV lines. Clearance of lines below CSA Standard of 5.5 m. Also a "Bottleneck" exists in the line limiting the carrying capacity	● Replace/relocate 18 wood pole structures ● Replace conductor ● Replace 6 mm dia. steel skywire with 8 mm dia. ● Replace or add new anchors where required
Thorold TS x Gibson Jct	Install a 115 kV interspaced structure. Clearance during summer peak load will be insufficient	Add a single pole structure in the Thorold Public Works yard
Manby TS x Runnymede TS x St. Clair Jct	Upgrade line by installing 2 structures	Install 2 - 25 m wood pole structures on Hydro owned right-of-way
Expand Newboro DS	The 115 kV station required to be expanded for the winter peak loadings	Existing site: 60 m x 45 m (.3 ha) New site: 90 m x 120 m (1.1 ha)
Allanburg TS x Allanburg West Jct	Operating temperature at peak load would increase sag beyond 5.5 m	Install single wood pole structure between existing 2 steel towers
Expand Tweed Lodgeroom DS	Require expanding station for winter peak load	Replace 4 single phase transformers with single 3 phase transformer and expand site
Woodstock TS — Work associated with increase in capacity	The facilities require upgrading	● Replace 3 transformers with single large unit ● The high voltage structure will be modified ● 3.6 m wide service road added to westerly limit ● Fence relocated 1.5 m beyond existing location ● Temporary facilities will be established for approximately 1 year
Ardoch DS — Install switches	Interruptions resulting from maintenance activities and unplanned outages cannot be prevented without switches	Install 2 airbreak switches on short steel towers on the centre line of right-of-way

Appendix I
Initial Notification Requirements

Table I-1 provides a description of the notification requirements which have been agreed to by Ontario Hydro and the Provincial Ministries, as of January 1, 1984. The listing will be updated on a need basis and agreed to by the respective parties.

TABLE I-1
Initial Notification Requirements for Provincial Ministries
Class EA — (Minor Transmission Facilities) Projects

Ministry	Notification Requirements	Additional Comments
I. Primary Group		
1. Environment	Mandatory — all projects	
2. Energy	Mandatory — all projects	
3. Transportation and Communication	Mandatory — all projects	Contact Regional Manager, Engineering and right-of-way office, who will advise if further involvement desired
4. Natural Resources	Mandatory — type A[1] Selective — type B & C[2]	Notify of type B & C projects if onto new property or MNR concerns affected. Smaller projects also notify district and regional offices
5. Citizenship and Culture	Mandatory — type A Selective — type B & C	Notify of type B & C projects if new land disturbed or archaeological or other man-made heritage features affected
6. Municipal Affairs and Housing	Mandatory — type A Selective — type B & C	Notify of type B & C projects if ministry lands, parkway belt west plan or facilities affected
7. Northern Affairs	Mandatory — type A Selective — type B & C	Only concerned about projects north of Parry Sound and Algonquin Park
8. Tourism and Recreation	Mandatory — type A Selective — type B & C	Notify of type B & C projects if ministry lands, facilities, commercial tourist facilities and attractions or interests are affected
II. Secondary Group		
9. Agriculture and Food	Selective — all projects	Notify only if classes 1 - 4 or lands in agricultural use are affected
10. Education	Selective — all projects	Notify only if project is in close proximity to school board properties. Also inform relevant school board
11. Health	Selective — all projects	Notify only if ministry lands, facilities or interests affected
12. Government Services	Selective — all projects	Notify only if ministry property is affected.
13. Community and Social Services	Selective — all projects	Notify Region Managers if ministry lands, interests facilities affected

TABLE I-1 (cont'd)
Initial Notification Requirements for Provincial Ministries
Class EA – (Minor Transmission Facilities) Projects

Ministry	Notification Requirements	Additional Comments
14. Attorney General	Selective – all projects	Notify only if ministry lands are affected
15. Correctional Services	Selective – all projects	Notify only if MCS operated institutions potentially affected
16. Colleges and Universities	Selective – all projects	Notify affected institutions only
17. Solicitor General – Office of Fire Marshall	Selective – all projects	Notify only if emergency fire service affected
18. Industry and Trade	Selective – type A Nil – type B & C	Notify of type A projects only if industry or trade negatively affected
19. Intergovernmental Affairs	Nil – all projects	Require no Class EA project notification
20. Consumer and Commercial Relations	Nil – all projects	No initial notification required on any Class EA
21. Labour	Nil – all projects	Notify only as Occupational Health and Safety Act applies
22. Revenue	Nil – all projects	Do not advise on any projects in conjunction with the EA Act
23. Treasury and Economics	Nil – all projects	Require no Class EA project notifications

Notes to Table – Project Type Description

[1] *Type A*

The planning of, the acquisition of property for, and the design and construction of, a minor transmission line and/or a minor transformer station and/or a communication tower and the subsequent operation and maintenance of these facilities.

Minor transmission lines include all transmission lines longer than 2 km which:

1. *Are capable of operating at a nominal voltage level no higher than 115 kV.*
2. *Are capable of operating at a nominal voltage level higher than 115 kV and which are shorter than 25 km.*

Minor transformer stations include those stations whose nominal operating voltage is not less than 115 kV and not more than 230 kV.

[2] *Type B*

The planning, property acquisition, and design and construction required to modify or upgrade a transmission line, and the subsequent operation and maintenance of the revised line where:

1. *The work requires replacement of structures and/or changes in the right-of-way.*
2. *The revised line is capable of operating at a nominal voltage level of at least 115 kV.*

Type C

The planning, property acquisition, design and construction required to modify or expand a transformer station and the subsequent operation and maintenance of the revised station where:

1. *An extension of the site is necessary.*
2. *The revised station is capable of operating at a nominal voltage level of not less than 115 kV and not more thatn 230 kV.*

Appendix J
Subsequent Communication with the Public

At the conclusion of the environmental study, elected and appointed officials will receive copies of the environmental report filed with MOE. Reports will also be sent to those individuals who have expressed an interest in receiving one.

On projects where an Order-in-Council is not required, a letter will be sent to each owner giving the planned construction schedule and the name and telephone number of the designated construction representative. This representative will be available for further discussion during the construction period. The letter may also include other project contacts such as the surveyors, the project engineer, the property agent and the community relations officer.

In cases where an Order-in-Council has been obtained, and there are several property owners involved, an information centre will be held. Property owners will have an opportunity to discuss tower locations, centreline survey, property policies, construction and restoration operation activities.

Following the information centre, or if no information centre is necessary, each property owner will be visited. Permission will be requested at this time for carrying out surveying, soil testing, property appraisals and woodlot evaluation as required.

Following the permission calls, appraisal work is commenced. Upon completion of the appraisal, a meeting is then arranged with the owner to discuss the offer of compensation.

When property is to be expropriated, a Notice of Application for Approval to Expropriate is delivered to each owner and the expropriation procedures explained. Once an expropriation has been approved, and if the owner has not yet settled, an offer of compensation under Section 25 of the *Expropriation Act* will be made. If agreement on compensation cannot be reached, after further negotiation the matter may be referred to the Board of Negotiations and/or the Land Compensation Board.

During construction, property owners and elected and appointed officials will be kept up-to-date on construction activities by project newsletters.

Appendix K
Examples of Typical Mitigation Measures

TABLE K-1
Examples of Typical Mitigation Measures

Environmental Concerns	Mitigation Measures	Application
WATER QUALITY		
Sedimentation of streams due to erosion from the right of way.	– minimize use of slopes adjacent to streams.	During soil testing, selective cutting, construction and maintenance.
	– maintain a cover crop.	During restoration following construction and long term maintenance
	– mechanical erosion control.	
Stream bank erosion.	– retain shrubby stream bank vegetation and selectively cut or prune trees.	In line clearing/maintenance.
	– selective spraying of herbicides	During line maintenance.
	– mechanical erosion control.	Stream crossings, as required.
Impedance of natural flow of streams/-other surface waters.	– use and maintenance of appropriate stream crossing device.	At stream crossings during construction and line operation.
	– use of equalizing culverts in roads in wetlands.	During construction and throughout line operation.
	– use of corduroy in wetlands, where available.	Line construction in wetlands.
Ponding or channelization of surface waters due to rutting.	– timing activities to stable ground conditions.	Construction/maintenance on seasonally unstable ground surfaces.
	– use of gravel roads.	New line construction on unstable ground surfaces.
Contamination of surface or ground waters through spills or leaks of toxic substances.	– spill control material and procedures readily available.	At station sites and in general wherever toxic substances are used.
	– site selection where possible.	Stations warehousing sites and structure locations.
Sedimentation of streams with pumped soil/bentonite from dewatering operations	– containment of material when working in the vicinity of water bodies.	Dewatering during installation of augered footings.
	– use of sediment traps or settling tanks.	When necessary during dewatering operation.
	– removal of material from the site.	Restoration.
Channel disturbance, sediment production at stream crossings.	– installation of an appropriate crossing device.	During access road construction.
	– use of sediment traps or settling tanks.	During access road construction.
Increase in water temperature due to vegetation removal at stream crossings.	– retain shrubby stream bank vegetation and selectively cut/prune trees.	Line clearing/maintenance.
	– selective spraying of herbicides to retain as much vegetation as possible on stream banks.	Line maintenance (vegetation control).
Reduction in water storage capacity due to removal of vegetation or diversion caused by rutting.	– selective removal of vegetation.	In identified source/recharge areas during initial line clearing.
	– revegetation with compatible shrubs.	Selection of structure sites and access routes.
SOILS		
Soil compaction/topsoil-subsoil mixing.	– avoidance of rutting by vehicles.	Applicable in generally all phases of construction and maintenance, particularly during line clearing & construction.
	– construction timing.	"
	– use of gravel roads.	"
	– use of vehicles with low bearing pressure.	"
	– stop activities when ground conditions are poor.	"

TABLE K-1 Cont'd.

Environmental Concerns	Mitigation Measures	Application
AGRICULTURE (cont'd)		
Disturbance to Farm Operations	– maintain contact with landowner/tenant regarding preferences.	Throughout construction and as maintenance work is required.
Damage to Field Tiles	– avoidance of tile beds.	Access road location landowner contact.
	– minimize tile crossings.	Access road layout.
	– scheduling activities to times of the year when ground will support the equipment to be used.	All phases of construction/maintenance where the location of tile drains is known.
	– use of soft track equipment.	Construction/maintenance.
	– protection of tile crossings by the placement of heavy steel plate.	Construction/maintenance.
	– stop activities when ground conditions are poor.	Field decision during construction phase of project.
	– repair damaged drains.	Restoration.
	– compensate for damages.	As a result of negotiated settlement.
Loss of Livestock	– employ noise control measures near sensitive livestock.	During construction as required.
	– construction of farm gates.	Access road – construction.
	– securing farm gates.	All activities.
	– clean-up construction materials which could be ingested.	As an ongoing process throughout all phases of construction and maintenance.
	– compensation for lost, injured livestock.	Following completion of construction, as a result of negotiations with claimant.
SOCIETAL IMPACTS		
Noise and Vibration	– limit this type of work to daylight hours.	All phases of construction where high noise levels could be a problem, e.g. residential areas.
	– observe protocol or applicable municipal bylaws.	All phases of construction where high noise levels could be a problem, e.g. residential areas.
	– use of appropriate methods where available.	As required – special circumstances. e.g. hospitals.
Mud and Dust	– wetting down dry soils.	All phases of construction.
	– chemical control of dust.	As required.
	– cleaning roads to remove mud.	As required.
	– temporary planting of grasses.	When the project duration permits and dust is a major problem.
	– screen with natural or planted vegetation.	Access roads – right of way clearing; restoration.
	– avoid linear access down the right of way.	Access road location.
	– addition of topsoil to gravel access roads.	Restoration of access roads.
	– hoarding construction sites.	Station construction.
	– installation of landscaping in advance of site completion	Station construction.

TABLE K-1 Cont'd.

Environmental Concerns	Mitigation Measures	Application
FISH AND WILDLIFE (cont'd)		
Change in the chemistry of water bodies.	– minimize sedimentation of streams (see Water Quality).	Near watercourses during line clearing, construction and throughout the operation of the line.
	– prevent cut vegetation from entering water-courses.	Line clearing and maintenance cycles.
	– selective spraying or manual control of vegetation near water-courses.	Line clearing and maintenance cycles.
Increased water temperature as a result of clearing vegetation near streams.	– selective removal of vegetation; pruning.	At stream crossings during line clearing and maintenance cycles.
	– retain shrubby bank vegetation.	At stream crossings during line clearing and maintenance cycles.
VEGETATION		
Introduction of exotic plant species resulting from vegetative erosion control.	– use of native species for erosion control.	On areas where erosion control is necessary.
Vegetation stress due to nutrient loss as a result of soil deterioration.	– erosion control measures.	The management of the right of way erosion prone slopes.
Changes in vegetation due to soil disturbance (topsoil-subsoil mixing).	– time construction/clearing to take advantage of stable soil conditions.	During construction and line clearing operations, maintenance cycles.
AGRICULTURE		
Loss of standing crop due to access road and tower work site.	– limit width of access and size of tower site.	Agricultural areas – generally all construction/maintenance operations.
	– monetary compensation for crop loss.	Following determination of losses.
	– time construction to avoid growing season.	Construction/maintenance.
Soil Compaction	– scheduling activities to times of the year when soils are least susceptible to compaction.	Construction/maintenance.
	– stop activities when ground conditions are poor.	Construction/maintenance.
	– use of equipment with low bearing capacity.	Construction/maintenance.
	– chisel ploughing.	Restoration.
	– monetary compensation for subsequent crop reductions.	Property settlements.
	– use of gravel roads.	Construction of new lines.
	– locate access roads along existing traffic routes.	Construction/maintenance.
Topsoil-subsoil mixing/soil rutting.	– scheduling activities.	Scheduling for construction/maintenance activities.
	– stop activity when ground conditions are poor.	Field decisions during construction phase of project.
	– use of equipment with low bearing capacity.	Construction/maintenance.
	– use of gravel roads.	Construction.
	– backblading/grading.	Restoration.
	– addition of manures to offset fertility loss.	Restoration.
	– compensation for reduced soil productivity.	As a result of negotiated settlement.
	– removal of spoil and/or bentonite from foundation operations.	Augered foundations.
	– segregation of topsoil and subsoil.	Where required to prevent extensive mixing.

TABLE K-1 Cont'd.

Environmental Concerns	Mitigation Measures	Application
SOILS		
Wind/water erosion.	– avoidance of areas with high erosion potential.	Access road location erodible soils, slopes.
	– timing activities to the most stable ground conditions.	Access road location erodible soils, slopes.
	– slope stabilization.	As required.
	– mechanical erosion control.	As required.
	– vegetative erosion control.	Erodible soils, slopes, as a restoration measure.
	– recompaction of trenches.	Installation of counterpoise, underground transmission lines.
	– avoid trenching parallel to the fall of a slope.	Counterpoising on steep slopes.
Contamination by petro-chemicals.	– spill control material and procedures made readily available.	At station sites or during the transport of oil containing equipment.
	– restoration methods investigated.	As an ongoing process.
FISH AND WILDLIFE		
Loss of habitat, breeding and/or food source for terrestial wildlife due to vegetation removal.	– environmental mapping to identify sensitive sites.	Prior to the start of construction, line clearing.
	– avoidance of areas containing rare/-endangered species.	Access road location, selective clearing for new lines.
	– the creation of "edge" (may be considered a positive impact).	Selective clearing on a right of way.
	– promotion of wildlife habitat through vegetation control and brush piles.	Restoration and right-of-way management.
	– avoid the filling of small wetlands.	Access road and tower construction.
Changes in composition of vegetation as a result of soil disturbance.	– construction timing to minimize soil disturbance.	Right of way clearing and construction activities in general.
	– restoration of soils to a stable condition.	Restoration following construction.
Removal or burial of stream bottom habitat and increased turbidity due to sedimentation.	– minimize erosion from the right of way by maintaining a cover crop.	Restoration and maintenance.
	– mechanical erosion control.	As required during the operation of the line and maintenance of the right of way.
	– minimize stream bank erosion by retaining shrubby bank vegetation and selective cutting/pruning of trees near watercourses.	At stream crossing during right of way clearing.
	– installation of sediment traps when necessary.	At any time during construction as required.
	– containment or filtering of pumped spoil/water near watercourses.	During the installation of tower footings near watercourses.
Impediment to the migration of fish or wildlife.	– avoid filling small wetlands serving as staging areas for waterfowl migration.	Small wetlands during access road and tower pad construction.
Impediment to the migration and/or breeding of fish or wildlife.	– installation and maintenance of a proper stream crossing device.	At stream crossings during construction and as required for maintenance.
	– time construction activities to avoid disturbance to migrating fish and wildlife or during breeding.	During construction and maintenance.
	– follow Ontario Hydro standards for the application of herbicides near water-courses.	Near watercourses during line clearing and maintenance cycles.

TABLE K-1 Cont'd.

Environmental Concerns	Mitigation Measures	Application
SOCIETAL IMPACTS (cont'd)		
Appearance — Lines	— retain tree screens and curve access routes	where appropriate vegetation exists.
	— plant tree screens	where appropriate
	— avoid sensitive soils for access routes	where possible
	— stabilize erodable soils by vegetative or mechanical means	where soils are subject to erosion
	— add topsoil and seed gravel access routes	where exposed to public view
Appearance — Stations	— Paint hoarding to suit locale	where appropriate
	— Install landscaping treatment in advance	where construction program and site size permits.
Inconvenience	— Select cable design to suit traffic conditions	where possible
	— Select timing of construction	where scheduling permits
Heritage Resources	— structural and/or locational adjustments	As required
	— on and off site landscaping	As required
	— install suitable enclosures	As required
	— document and remove resource	As required
	— relocate electrical facilities	As required

Note: The nature of the environment in the study area will determine the potential environmental effects for any project. Mitigation to address these effects will be determined on a case by case basis. Alternatives will be evaluated on the basis of net environmental effects (i.e., environmental effect — mitigation = net environmental effect).